A Lessons Learned Knowledge Warehouse to Support the Army Knowledge Management Command-Centric

Dr. Pierrette Champoux, Martin Trudel M.Sc.
DMR Consulting
Place Iberville Trois 2960, boulevard Laurier, bureau 400
Sainte-Foy, QC G1V 4S1
CANADA
Phone: 1 (418) 653-6881
Fax: 1 (418) 653-4428
Email: {pierrette_champoux, martin_trudel}@dmr.ca

Gaétan Thibault M.Sc.
Defence R&D Canada - Valcartier
2459 Pie-XI North
Val-Belair, QC G3J 1X5
CANADA
Phone: 1 (418) 844-4000
Fax: 1 (418) 844 4538
Email: gaetan.thibault@drdc-rddc.gc.ca

ABSTRACT

The Canadian Army Lessons Learned Knowledge Warehouse (ALLKW) is at the heart of the environmental Knowledge Management (KM) strategy to support the Canadian Land Force Operational Model centered on Command. This paper presents the Army Lessons Learned System and Process (ALLP) that is part of the approach for gathering observations and comments from operations and exercises in order to support lesson elicitation, action identification as well as proper follow-up. Along with the description of the LL Processes, a focus will be made on how the current system could be improved in order to facilitate its integration within the Intelligence, Surveillance, Target Acquisition and Reconnaissance (ISTAR) Information-Centric Workspace Processes, in particular the interaction and use of such a system with the Data Fusion Processes and System.

1.0 INTRODUCTION

Over the years, the Army has faced numerous changes with regards to personnel and resources availability, aging and knowledgeable workforce reductions, re-engineering, and culture upheaval. The shift to more frequent, complex and demanding peace support missions and the perspective of a possible engagement in a war reinforces the needs for the Army to migrate to a '*…knowledge-based and command-centric institution capable of continuous adaptation and task tailoring across the spectrum of conflict…*'[1]

The Command function is foreseen as the centre of activities linking all other operational functions, Sense, Act, Sustain and Shield within a single multi-level operation concept designed to simultaneously achieve tactical, operational and strategic goals. [2] '*The command-centric view of knowledge management is integral to the command support capability. It focuses on the usefulness of implementing knowledge management processes, techniques and tools to support Army commanders during decision-making in an operational context*.' [3]

The Army Knowledge Management Strategy overall intent is the '*…optimal development of common/shared intent and improvement of the synchronization between commanders and staff…*' [3]. One way of improving this synchronization is by the transformation of key tacit knowledge into explicit knowledge, which will

Paper presented at the RTO IST Symposium on "Military Data and Information Fusion", held in Prague, Czech Republic, 20-22 October 2003, and published in RTO-MP-IST-040.

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
00 MAR 2004	**N/A**	**-**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
A Lessons Learned Knowledge Warehouse to Support the Army Knowledge Management Command-Centric	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **DMR Consulting Place Iberville Trois 2960, boulevard Laurier, bureau 400 Sainte-Foy, QC G1V 4S1 CANADA; Defence R&D Canada - Valcartier 2459 Pie-XI North Val-Belair, QC G3J 1X5 CANADA**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES
See also ADM001673, RTO-MP-IST-040, Military Data and Information Fusion (La fusion des informations et de données militaires)., The original document contains color images.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**UU**	**57**	

increase the quality and availability of information in context (knowledge) to the decision maker in a timely manner.

One of the first Knowledge Management (KM) initiatives that was foreseen and undertaken by the Army is the development of the Lessons Learned Knowledge Warehouse (LLKW). The aim of the LLKW System is to support the Army throughout the entire process of gathering, organising, analysing, tracking action, and disseminating knowledge (e.g. lessons learned) related to field operations and exercises and, thus, improving effectiveness of the Army's combat capabilities. In the Army KM Command-Centric-View, the LLKW System is a supporting element to the Commander's decision (figure 1) [3].

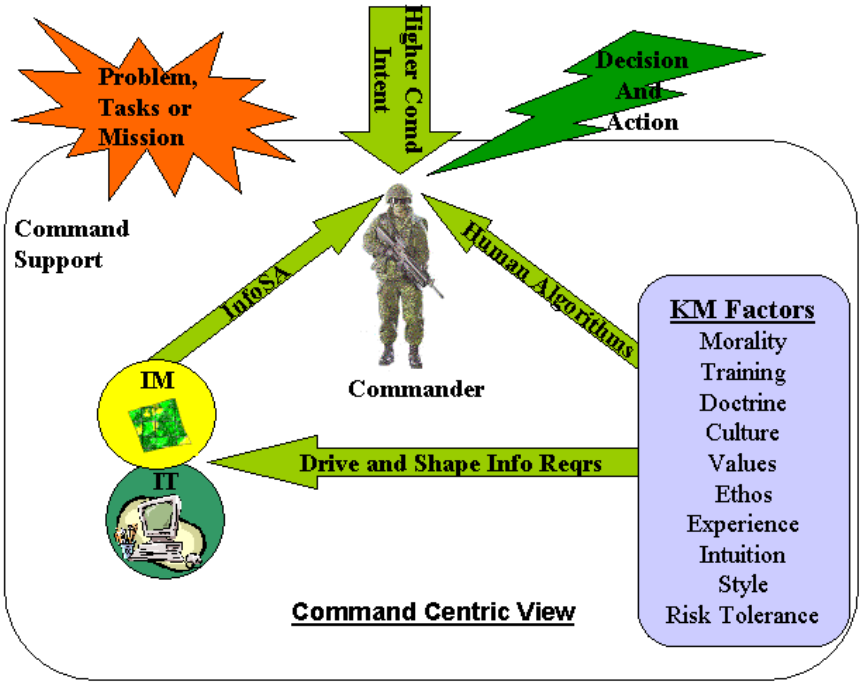


Figure 1: Army KM Command-Centric View [3].

Also, the LLKW is one of the systems integrated into the Intelligence, Surveillance, Target Acquisition and Reconnaissance (ISTAR) System of systems Information-Centric Workspace [4], whose aim is to provide a more coherent information management approach to better support the Commander. The Systems integration features numerous challenges and is highly influenced by the available technical skills and the ability to adapt processes, doctrine, organisation and culture. [5]

Data Fusion is one of the main processes in the ISTAR Information-Centric Workspace. From the initial Data Fusion Lexicon, produced by the Joint Directors of Laboratories (JDL) in 1987, Data Fusion is defined as:

> '*A process dealing with the association, correlation, and combination of data and information from single and multiple sources to achieve refined position and identity estimates, and complete and timely assessments of situations and threats, and their significance. The process is*

characterized by continuous refinements of its estimates and assessments, and the evaluation of the need for additional sources, or modification of the process itself, to achieve improved results.' [6]

This paper provides a description of the ALLKW development context to identify the scope of the projects that lead to its realisation. An introduction of the Data Fusion Process Model is made along with a presentation of possible interactions and similarities between LL and Data Fusion. Then, each phase of the LL process is described whereas potential improvements to the current system are identified with regards to the Data Fusion context.

2.0 ALLKW DEVELOPMENT CONTEXT

The creation, sharing and re-use of Lessons Learned lead the way among the best practices in any organisation [7], [8] and [9]. In particular, Lessons Learned (LL) have always been at the core of the fundamental knowledge assets in Command and Control environments. As a part of their traditional culture, the military personnel has reported observations or lessons after operations or exercises. Past operations lessons convey an important experiential knowledge (both about successes and failures) that can be learned, re-used or avoided in future similar situations in a way to make the best decisions and undertake the best actions (e.g. preparation of future operations, selecting best course of actions, etc.). The sound re-use of human and intellectual capital is the main constituent for the creation of a safe and efficient culture within the Army.

In 2001, the Canadian Forces had a requirement to provide the Army Lessons Learned Center with a new approach for the management and publication of the Army Lessons Learned. The past Lessons Learned Systems were based on technologies dating from the early 1980's which at the time relied little on IT applications while requiring a lot of human resources. This approach did not easily support the evolution of the Army requirements, nor the re-use of the knowledge conveyed in the Lessons Learned.

The main requirements for the ALLKW were as follow: [9]:

(1) Accessing the System with a Browser similar to Internet Explorer

(2) Facilitating or enabling the capture of observations and comments from the Chain of Command

(3) Accelerating updates

(4) Providing tools to assist the Lessons Learned Analysts in the search and validation of specific issues as well as the identification of lessons

(5) Facilitating action tracking

(6) Enabling fast publishing

For the ALLKW System, these requirements aim at supporting the Army throughout the entire process of gathering, organising, analysing, tracking action, and disseminating knowledge (e.g. lessons learned) related to field operations and exercises and, thus, improving effectiveness of the Army's combat capabilities.

An Interim Operational Capability (IOC) of an Interactive Lessons Learned Knowledge Warehouse (ILLKW) was developed in 2001 in collaboration with the Defence R&D Canada Valcartier. This prototype [10] was instrumental in presenting the system to the Army personnel and was utilized to clarify the functional requirements for the Final Operational Capability (FOC) in 2002. The main objective in the development of the FOC was to ensure that the LLKW would provide functionalities covering the entire LL Process with

respect to budget, allowing the Army personnel to acknowledge the organisational changes to be pursued and capture future system requirements. The methodology used to develop and deploy the ALLKW follows the Canadian Forces requirement '*to develop a single methodology linking requirements, research, and acquisition through experimentation and fielding'*. [11]

The development approach was crucial in ensuring that the system would meet the Army requirements, in balance with the design of the entire LL Process, with the close participation of all stakeholders and end-users. The KM approach undertaken to develop the LLKW was a combination of both methods and techniques retrieved from the following three main concepts [12]:

- The User-Centric Approach which puts the emphasis on the tasks and the user early in the system development while measuring the reactions using prototypes, interfaces or any other means of simulation. The system development is realised using multiple iteration.
- The System-Centric Approach is mainly preoccupied by the flow of information and objects that are taken into account by the system while considering the user's perspective of validating and accepting the work or missions to be performed.
- The Process-Centric Approach considers the process from a centralised perspective, at the very core of the development. This process consists of a chain of activities that have an orderly priority in both space and time, with a beginning and an end for each activity as well as a triggering event.

The definition of the development context allowed for the identification of the scope and the extent of the current LLKW application. In order to facilitate the elicitation of new and future requirements, we must position the system in the context where it will interact and integrate with the other systems and their related processes, in this case the Data Fusion Process.

3.0 THE JDL DATA FUSION MODEL AND THE ALLKW

The Joint Directors of Laboratories (JDL) Data Fusion Group, established in 1976, has created and ever since maintained the Data Fusion Model used for categorising Data Fusion-related functions. [13]. This model was developed with the intent to facilitate the communications between military researchers and system developers. [14]

The top-level JDL Data Fusion Model gives a functional-oriented model, which was designed to be general but also suitable for different application domains. The top-level model (see figure 2) is composed of Sources of Information, Human Computer Interaction, Level 1 through 4 Processing and Database Management System.

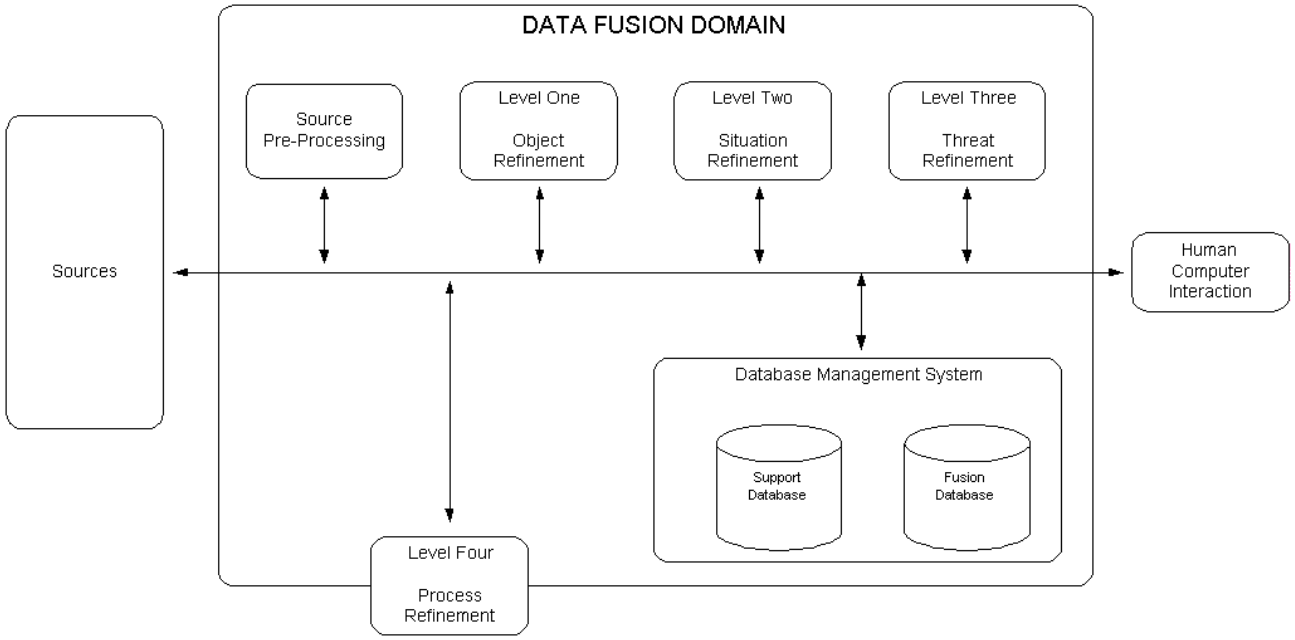


Figure 2: JDL top-level Data Fusion Model [13].

Each level is defined as follows [13]:

Level 1 – Object Assessment: estimation and prediction of entity states on the basis of observation-to-track association, continuous state estimation (e.g. kinematics) and discrete state estimation (e.g. target type and ID);

Level 2 – Situation Assessment: estimation and prediction of relations among entities, to include force structure and cross force relations, communications and perceptual influences, physical context, etc.

Level 3 – Impact Assessment: estimation and prediction of effects on situations of planned or estimated/predicted actions by the participants; to include interactions between action plans of multiple players (e.g. assessing susceptibilities and vulnerabilities to estimated/predicted threat actions given one's own planned actions);

Level 4 – Process Refinement (an element of Resource Management): adaptive data acquisition and processing to support mission objectives.

And, the Sources of Information and Human Computer Interaction concepts are defined as follows [14]:

- *Sources of Information*: indicate that a number of sources of information may be available as input including local and distributed sensors, reference information, geographical information, knowledge base, Intelligence data (HUMINT, SIGINT, etc.); and
- *Human Computer Interaction (HCI)*: allows human input such as commands, information requests, human assessments of inferences, reports from human operators, etc. It includes methods to assist humans in direction of attention, and overcoming human cognitive limitations (e.g. difficulty in processing negative information).

In our effort to map the LLKW System, Process and information with the JDL Data Fusion Model, we asked ourselves the following questions:

- How can the LLKW system be incorporated within the Data Fusion Process from the HCI point of view?
- Can the LL Knowledge Base provide any valuable information to achieve better estimates of the objects state? If this were the case, what should be the steps or actions taken?

From these interrogations, we were able to identify two main areas where these processes may interact. First, the current LLKW System may be foreseen as a Decision-Based System (DBS) assisting in the HCI (figure 3, item 1) that would be standardized into the Info-Centric Workspace of ISTAR [4]. Second, the LL Knowledge Base may be a source of information (figure 3, item 2) for the Data Fusion Process itself, thus provide contextual knowledge used in the different levels of fusion.

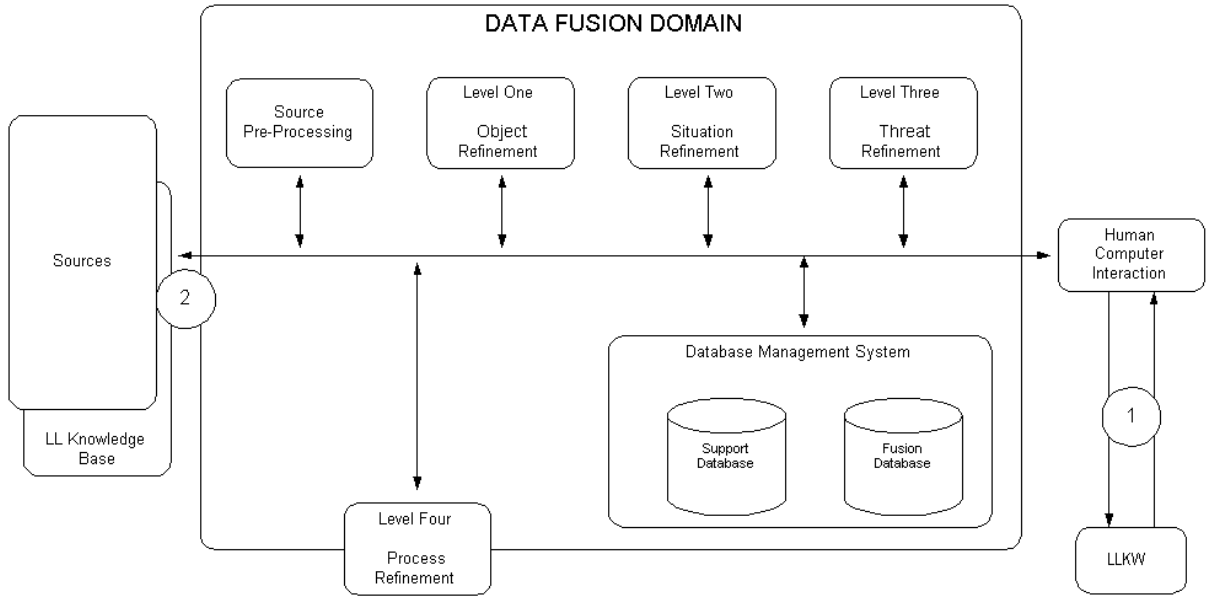


Figure 3: LLKW and Data Fusion interactions.

The relation between Data Fusion and the Command-Centric Approach envisioned for the Army of the future leads into considering the HCI as important input in the realisation of the overall process. From [15], Artificial Intelligence (AI) turned out to be an important tool for the application but lacked sufficient functional insight therefore putting emphasis on the feedback obtained through the HCI.

With this in mind, it is clear that task-support and decision-based systems will help in providing doctrinal, operational and contextual information essential for the realisation of the fusion operator's tasks. A LLKW application, comprised of fusion-related information, can be positioned as a two-way feedback system (figure 3, item 1) in the JDL model.

First, the application can provide a shared decision-based tool. This means that information, given through past experiences, raised issues and lessons, will be contextually available to the "fusion operators" while they are performing their tasks and thus providing:

- knowledge valuable for taking command level decisions;
- contextual knowledge while executing the required task; and
- re-use of past experiences (doctrine, best practices, etc.).

In the current LL System, this implies the creation of a Management Board, similar to a digital dashboard driven by its contextual inputs. It also means that the underlying knowledge base will have to hold information on the circumstances under which the knowledge was produced. This will eventually lead into the production of a more efficient search engine and, thus, better information would be pushed to the fusion operators.

Second, by defining a questionnaire based on the Data Fusion, the fusion operator will become a contributor or a Knowledge Analyst for the LL System and thus participate to the LL Processes as described in the next section. This enables the LL System to re-use the knowledge acquired by the operator during the execution of the Data Fusion Process.

The other main area of interaction between LLKW and Data Fusion is when the LLKW is used as a Source of Information automatically feeding the Data Fusion Process levels (figure 3, item 2).

The next section will present the Lessons Learned Process, with regards to what has been deployed for the Army and what should be modified in the future to support the Data Fusion Processes and make the integration possible in the context of the Canadian Forces Command-Centric view.

4.0 ALLKW CONTENT AND PROCESS

The actual LLKW is mainly composed of textual observations, from over 45 Operation/Rotation since 1996, that have been converted from the previous system into the newly Knowledge Model as shown on figure 4. The Army Lessons Learned Center (ALLC) is currently managing all other documents (e.g. Bulletin, Dispatch and Report Analysis) where one can extract past lessons through the Army On-line System. Further work by the ALLC is under development to link these historical documents to appropriate Knowledge Objects of the ALLKW, thus, giving direct access to relevant knowledge without any duplication of documents.

The Knowledge Model of the ALLKW presented in figure 4 consists of the followings knowledge object facets:

- The Knowledge structure facet regroups all objects related to the questionnaire structure: Phase, Theme, Subject, Question and Questionnaire.
- The Response facet is composed of the observation and comments objects. An observation or a comment is linked to specific questions of a questionnaire version and type (i.e. 2001, International Operation). Within the LLKW an observation is a response to a specific question and a comment is a response or a clarification on an observation.
- The Lesson Facet is composed of the Issue, the Lessons and the Staff action objects.
- The Organisational Structure facet is composed of the Organisation, the User, the Role and the Reporting Level, defined as the level of authority of an organisation when it answers a questionnaire.
- The Reference facet consists of the Workproduct object, which is a document produced by ALLC and the Reference Document object produced by other organisations.

- The Mission facet is composed of the Exercise, Operation and Rotation objects. Each Exercise or Operation/Rotation is linked to the current questionnaire at the time of its activation.
- The ETSS facet is composed of the Process, Task, Procedure and Step objects.

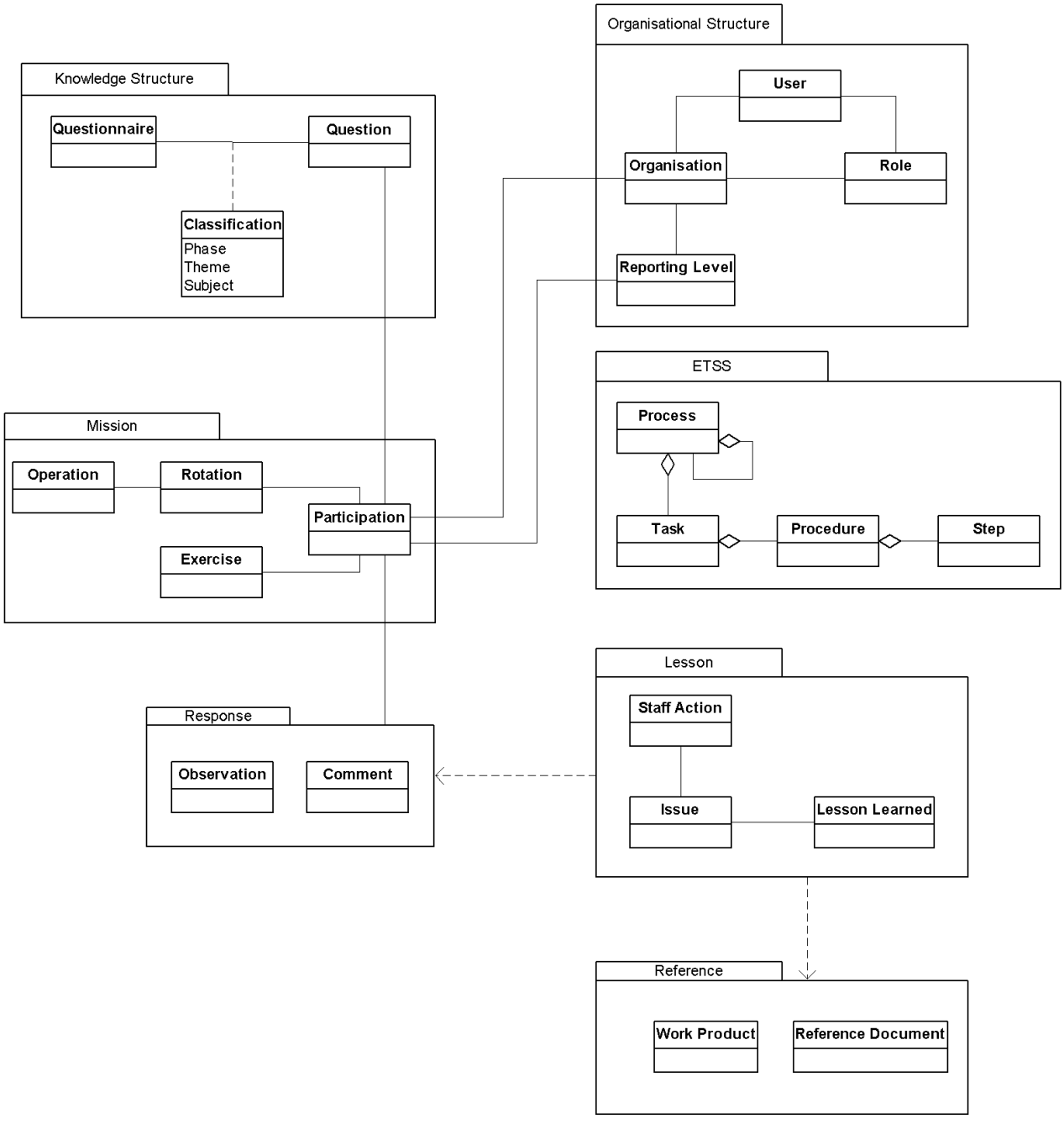


Figure 4: ALLKW Knowledge Object Model.

From the figure above, we observe that the Army is not only sharing Lessons but also sharing observations and comments from operations and exercises, which becomes the raw data that the Analyst will use to extract issues that eventually could become lessons or actions to be implemented.

The ALLKW is currently a standalone system that may be less effective because it forces the user to master a separate process [16]. In order to overcome this limitation, an Electronic Task Support System was embedded into the ALLKW, adding Knowledge about the Processes within the ETSS facet (figure 4). An Electronic Task Support System improves how military personnel are trained. It guides the users on how to use the LLKW and gives them access to the right amount of knowledge, at the right time, in relation with their role and, thus, enhances their tasks performance. The ETSS structures the knowledge in such a way that help is provided in context and dependent on what the user does, what role he has to play and what should be the minimum information about processes, tasks or procedures.

The ETSS brings forward all the explicit knowledge necessary to support the newly design LL Process, fulfilling, by such, the need for the '*Army to develop effective concept-to-fielding Cycle that include the integration of technology with the appropriate doctrine, organisation and training*' [11]. The ETSS is also a sub-system that is part of the LFC2IS and integrated into the ISTAR Canadian Info-Centric Workspace [4]. The same functionalities can be envisioned for the Data Fusion Processes where a user may have access simultaneously to knowledge about how to perform a task and what are the lessons learned associated to it, bringing forward the notion of a dynamic process of learning and sharing best practices [5].

It is mostly recognised in literature that the LL Process is a strategy to elicit, retrieve and re-use Lessons obtained from experiential knowledge [16], [8] and [9]. Processes of the Lessons Learned Process (LLP) are regrouped, supporting that strategy, under four main processes (figure 5) such as Knowledge Organisation, Knowledge Gathering, Knowledge Analysis and Knowledge in Action. Each phase is further described in the context of the LLKW currently deployed for the Army. The Canadian Forces agreed upon the composition of the LLP and are currently pursuing the development of the LLS to leverage the work overtaken by the Army and make it a Canadian Lesson Learned System where they will share knowledge and learn from it (figure 6).

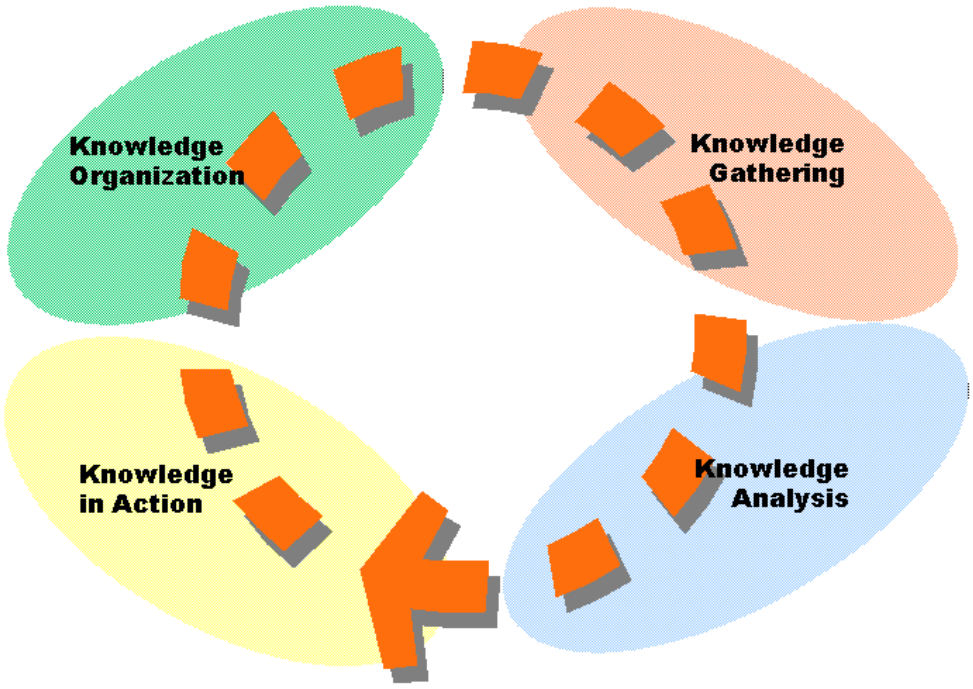


Figure 5: Phases of the Canadian Lessons Learned Process.

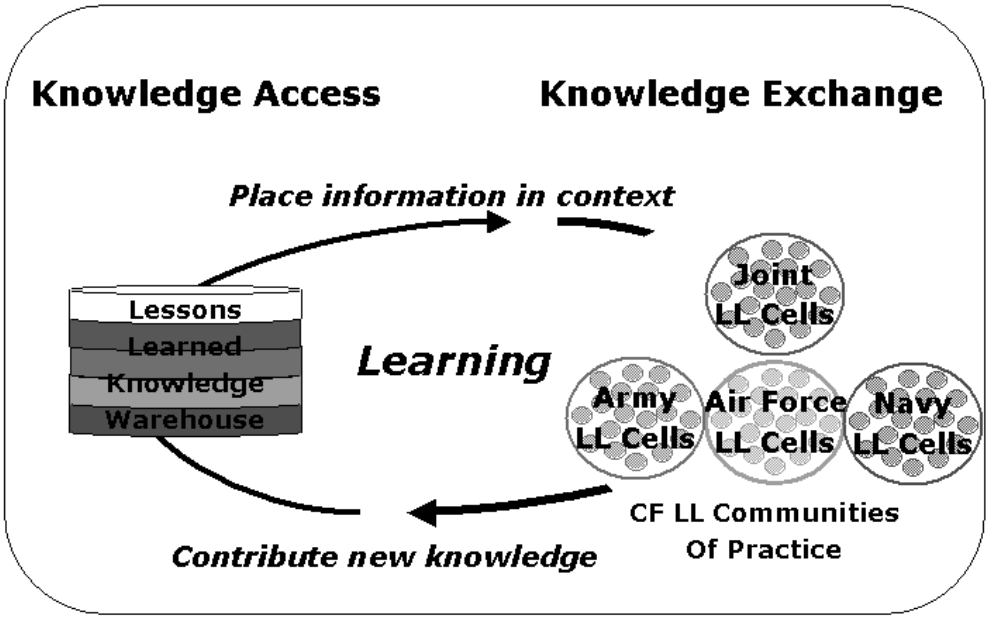


Figure 6: LLKW as part of the Canadian Knowledge & Learning Strategy.

4.1 Knowledge Organisation

At this particular phase, the aim is to organise or structure knowledge in such a way that it can easily be visualised, searched and managed. From the Army Lessons Learned Center perspective, and specifically for their analyst, the Knowledge Organisation phase is the entry point of the LL Process.

The sub-process of the Knowledge Organisation phase relates on how to manage and modify the knowledge structure such as the evolution or the creation of questionnaires, on how to manage the creation and edition of operation or exercise, on how to manage the Army organisational structure, and finally on how to profile the user's roles within current operations and/or exercises (figure 7).

When creating a mission or an exercise, the ALLC Analyst has to identify which organisation is involved at which Reporting Level within the Chain of Command and who will be the representative acting as contributor or Commanding Officer.

The use of questionnaires at the tactical level for operations and exercises is the Knowledge Gathering strategy for the Army. These questionnaires are known as Post Operation Report (POR) and Post Exercise Report (PXR). The structure to be managed for operations is based on questionnaires that follow a Phase, Theme and Subject hierarchy and a Theme and Subject hierarchy for exercise.

The LLKW manages all of the relationships between the different versions of questionnaires (i.e. Domestic Operation questionnaire). Some questions may be updated and kept within the same meaning (minor modification, clarifying a question) while some may be created, replaced or deleted in the future structure. The management of the historic of questionnaire allows the system to extract all observations from a current question and it's previous version. There is currently three official versions of the International Operational questionnaire.

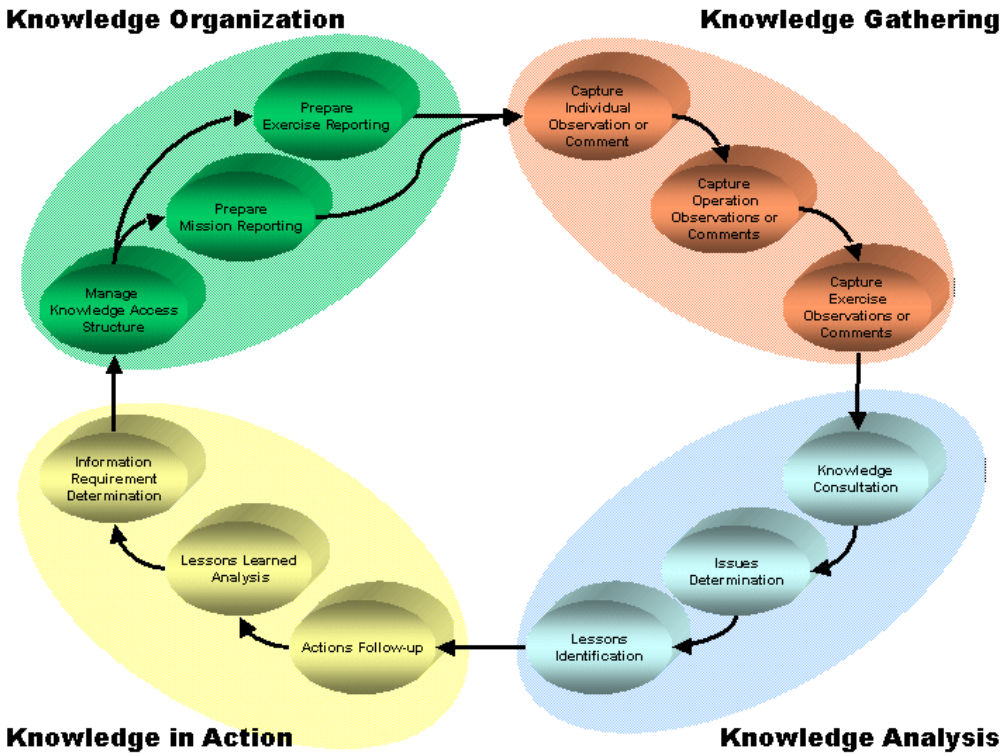


Figure 7: Main Sub-processes all Phases of the LL Process.

The effectiveness of a structured reporting context, i.e. the questionnaire, has been proven by its usage. When comparing LL applications where in one case a more rigid and task-oriented structure for capturing knowledge is defined and whereby, in the other case, a mission-oriented and free form is used, we observed that the essence of the observations was more meaningful with regards to the subject and related question, upon which it was supposed to be reported.

The task of capturing knowledge involves a cognitive process establishing the information that will be given, i.e. “knowledge mapping”, and how it will be formulated. By structuring and classifying the required inputs, it reduces the cognitive load and helps in the gathering of higher quality observations.

The questions were formulated in order to gather specific and important information on a particular aspect of the operation/exercise. The Warning, Mounting and Deployment phases gather the information on mission planning aspects, while the Employment and Re-deployment phases cover the mission execution aspects.

The following are questions taken from the POR International Questionnaire version 2002:

Phase: 3 - Deployment

Theme: Movement

Problems/Successes during the deployment Phase

a. What were the problems/successes encountered during the deployment phase with respect to:
(1) equipment availability?
(2) allocation of AORs?
(3) establishment of accommodation sites and infrastructure?
(4) communications?
(5) security?
(6) standing up the Contingent HQ?

Phase: 4 – Employment

Theme: Command and Control (C2)

Unit Deployment Detail

Briefly describe the unit deployment in terms of:
a. Tour dates
b. Sub-units
(1) Number and type of sub-units deployed (to include sub-unit function, major eqpt and parent unit title).
(2) Indicate if there was a change in unit organisation at sub-unit level for this mission.
(3) If re-roling was required, identify for applicable sub-units.
c. Total number of people deployed (Reg/Res)
d. Description of the location of the deployment (country/province/ major cities)
e. Were there momentous incidents or changes to the situation in the deployment area that had a major impact on the operation?

Theme: Information Operations

Climate Effects on Operations

a. How and to what extent were the operations affected by the climate?
b. How were the problems resulting from the climate overcome?

Theme: Operations

Manoeuvre Characteristics

a. Did the unit possess the mobility, firepower and protection necessary to conduct its mission?
b. If not what would be a better ORBAT for this mission?

Mine Threats and Counter-mine Measures

a. Was there a mine threat?
b. Were engineer resources adequate to deal with this threat?
c. Were there any mine incidents during the tour?

Requirements for Doctrinal Review

a. Are there tactics, organisations or procedures that should be reviewed as a result of this mission?
b. Were there any TTPs developed specific to this operation that could be of future use? If so, provide a brief description of the subject matter and a Point of Contact (POC).

The actual LL system mainly incorporates knowledge specifics to planning and execution of a mission in light of the way the questionnaires were defined. Also, the LLKW mostly contained unstructured knowledge from which it was not easy to perform any analysis or identify the reporting context. In order to structure the underlying knowledge so it can be accessed in the Data Fusion Processes, the following actions were identified:

a) Review the LLKW to capture the context in which the information was gathered, to categorize and structure the underlying knowledge, to control the way knowledge is captured and thus associating concepts with users inputs;

b) Define a unifying terminology that would be used in both the LL and the Data Fusion; and

c) Define a questionnaire to gather the domain-specific knowledge and identify at which Data Fusion Process level it is related;

a) Knowledge Base Improvements

Since the LLKW content is mostly textual, further work has to be performed to add more functions for capturing context, finding similarities, structuring users inputs, etc. The following describes some of the aspects that should be considered.

First, context information can be obtained by answering the following questions:

- **when** did the event happened, the conditions under which it happened, the actions that triggered the event;
- **where** did it take place, the elements that defined the surroundings, the weather, the location; and
- **what** was the task performed at the time of the event, the lesson to be learned, the topics covered, the content, etc.

Second, to store such information, we must categorize the knowledge by adding appropriate attributes to the existing knowledge structure. Keeping in mind that the environment is associated to a lesson by mapping concepts, a lesson learned with contextual information could have the following representation [17]:

- Originating Action
- Result
- Lesson Contribution
- Applicable Task(s)
- Conditions
- Suggestions

Categorization can be accomplished by associating a unifying terminology to the already existing knowledge. This facilitates knowledge elicitation while providing a mechanism to extract and analyse information in order to feed it back into the Data Fusion Process.

b) Unifying Terminology

To help provide information integration between the LL System and top-level Data Fusion Processes, the use of a unifying terminology is proposed.

'*Ontologies range from controlled vocabularies to highly expressive domain models. They are integrated data dictionary designed for human understanding, structured data models suitable for data management, and computational ontologies* [18]. '

Different categories are used to classify ontologies, but the one we are most concerned with are Domain ontologies. These structures represent specific concepts from a **domain** or field of expertise. In the case of knowledge retrieval from the LLKW, the domains targeted are top-level processes of Data Fusion level 2 and 3, i.e. Situation and Threat Assessment.

'*With ontologies, information integration from heterogeneous sources can be addressed at the structural, syntactic or semantic levels. These are used to make the content more explicit* [18].'

As a result from the Joint Directors of Laboratories (JDL) Data Fusion Working Group to codify the terminology related to Data Fusion, an effort was made to create a Data Fusion Lexicon [6].

c) Questionnaire Approach

Using the questionnaire approach, domain experts and Knowledge Analysts have to link the knowledge structure with the different concepts used in the construction of the Domain Ontology. By doing so, information can be easily re-used for further analysis or as a feed for the Data Fusion with additional inputs.

For example, if we refer to the questionnaire sample given in scenario 1, the question categorized under
Phase: 4 – Employment,
Theme: Command and Control (C2)
Subject – Unit Deployment Detail
can give information regarding level 2 fusion for the Force Deployment concept.

Also, for level 3, the question associated with
Phase 4 – Employment
Theme: Operations
Subject – Mine Threats and Counter-mine Measures
can give some insights on the Enemy Force Capability, activities, etc.

4.2 Knowledge Gathering

The main objective of this phase is to manage observations and comments gathered in relation to an operation or exercise. This phase is the entry point of military personnel involved in an operation or an exercise.

The sub-processes for the Knowledge Gathering phase relates on how to capture observations, how a Commanding Officer approves observations and comments within his organisation, how to add additional observation that doesn't fall under an official POR or a PXR and finally how to integrate related reference documents (figure 7).

Observations and comments are captured on-line by contributors and approved by the Commanding Officer for each organisation associated to a specific Reporting Level. The distinction between observations and comments allows users to easily visualise and follow a discussion on a particular subject within the context of an operation or an exercise. The sequence of observations and comments follow the Chain of Command from the unit level up to the higher level. One of the benefits of the on-line capture of knowledge is the possibility

to access observations and comments as soon as the Commanding Officer has approved his knowledge acquisition.

At this phase, one of the potential outcomes from applying a unifying terminology for categorisation of the observations and comments is that the users inputs could be formed and controlled by series of concepts taken from that same terminology. This controlled vocabulary ensures consistency between LL knowledge and Data Fusion information.

4.3 Knowledge Analysis

The main objective of the Knowledge Analysis phase is to seek knowledge on different topics, validate issues and stimulate learning while doing operations and exercises. This phase is the entry point of a wide range of users that are interested in learning about previous experiences and increase their state of preparedness for operations or training.

The sub-processes for the Knowledge Analysis phase relates on how to consult, analyse and extract knowledge, how to manage issues and lessons, how to capture comments on issues and lessons from an Office of Primary Interest (OPI) and finally, how to link knowledge objects such as observations to support Issues or Lessons (figure 7).

The actual LLKW offers two ways of accessing knowledge; either by browsing through the site or by searching with specific criteria related to knowledge objects or knowledge structures.

When browsing through the LLKW, the Analysts will always have access to knowledge objects through Views presenting knowledge by specific attributes (i.e. by name, by date, by OPI). A filter function is also available to assist the Analyst when he browses through a questionnaire structure. This function limits access to specified knowledge objects by filtering the pages content. This enables to discard any irrelevant information that would, otherwise, be treated.

The knowledge extraction can be accomplished by using the full text search capabilities in combination with criteria, such as the type of operation or exercise, the phase, theme, or subject of a questionnaire and/or from the organisation (figure 8).

Several research projects at the Defence R&D Canada Valcartier are under development to find ways of assisting the Analyst during the Knowledge Analysis phase. Among those, some projects examine how to find similar observation or lesson [9] or how to better classify and find knowledge with the use of multiple ontologies and intelligent agents [19].

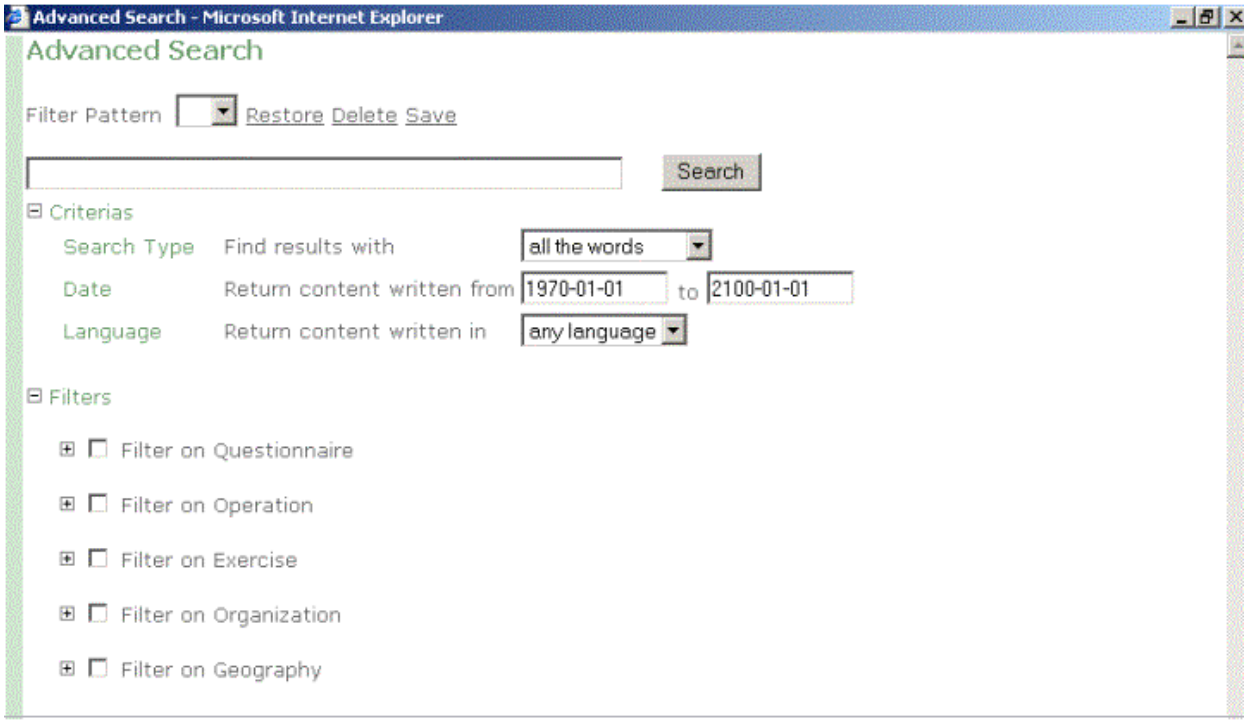


Figure 8: Advanced Search Criteria of the ALLKW.

4.4 Knowledge in Action

The main objectives of the Knowledge in Action phase is to gather recommendations and decisions from staff authorities, insuring that proper actions are taken and lessons are learned. This phase is the entry point of the stakeholder, OPI, Staff, Commander, ALLC Staff with the main concern to follow up on actions but also to contribute to the LLKW by adding their comments, recommendations or decisions on issues that falls under their command.

The sub-processes for the Knowledge in Action phase relates on how to manage Staff Action, how to capture comments, recommendations and decisions on Issues and how to confirm whether or not a Lesson has been learned (Figure 7).

This phase was the most difficult one to design during the development phase of the ALLKW. Part of this is due to the fact that the ALLC, at the time of development, weren't empowered to make things happen without direct leadership and responsibility. Their limit of responsibility was to propose, suggest, and try to gather comments and decisions from Staff. The direct involvement of Staff would occur only when it fell under their roles and responsibilities.

The ALLKW offers a way of accessing and managing Staff Action but these sub-processes will need to be improved as soon as the Staff becomes aware of what the system can offer. Unfortunately, Staff personnel weren't involve during the ALLKW design phase, thus the proper balance between the users, processes and system views, regarding the Knowledge in Action phase, will have to be obtained through future developments in order to maximize the benefits of the new technologies.

5.0 CONCLUSION

The current Army Lessons Learned System is deployed as a standalone system but will soon be integrated into the Land Force Command and Control Information System (LFC2IS) through the proposed Canadian ISTAR Information-Centric Workspace System of Systems Vision [4]. The System will provide knowledge to Commanders within their operational context. For doing so in a timely manner and without to much processing effort, we have already identified that knowledge must be properly organised, structured and classified in such way that it can be easily exploited to automatically provide (i.e. push and pull) relevant lessons for specific situation. The right balance between text and structured text within the database will have to be addressed in light of all the possibility the technology offers to extract relevant knowledge.

The Data Fusion System and Process is also an important component of the ISTAR Information-Centric Workspace and, as such, it will benefit from the integration of the LLKW in gathering information and knowledge linked to the process itself or by providing an easy access to any relevant information already captured in similar situation.

The Army Lessons Learned Process can easily be mapped with the top-level Data Fusion Process. The main difference is the notion of level of abstraction for knowledge objects or the context from which we look at the model.

The top-level Data Fusion Process Model was intented to be a generic model that can be applied in different situations. For this reason, we compared the Data Fusion process levels to the ones described in the LLP.

The following table shows the association that was made between the different processes and components. We can observe that only the nature of the objects differ.

Data Fusion		**Lessons Learned**	
Processes	**Components**	**Components**	**Processes**
Level 1 – Object Refinement	Data alignment Data object/correlation Position/kinematic and attribute estimation Object identity estimation	Observations Comments	Knowledge Gathering
Level 2 – Situation Refinement	Object aggregation Event/activity interpretation Contextual interpretation	Issues Lessons	Knowledge Analysis
Level 3 – Threat Refinement	Aggregate force estimation Intent prediction Multi-perspective assessment	Actions Lessons Learned Recommendations	Knowledge in Action
Level 4 – Process Refinement	Performance evaluation Process control Source requirement determination Mission management	Questionnaires management Organisational Structure modification Reporting Context definition Users and Roles determination	Knowledge Organisation

Moving towards a Command-Centric vision implies that knowledge must be shared between organisations.

For the last two years, the Lessons Learned Joint Staff has hosted several workshops in an effort to bring all environmental parties (Army, Navy, Air Force, Joint) towards building a common understanding of the Lessons Learned Process and a shared vision of the Canadian Forces Lessons Learned Knowledge Warehouse. Each of them agreed that the Army LLKW System could be used as a starting point to provide a better understanding of technical and organisational requirements. From these emerged the need to manage multiple knowledge structure or context, to modify their actual LL Process or to identify specialised personnel. Each environment also agreed to the fact that they need to share information as soon as it's validated by the Commanding Officer and transmitted forward into the Chain of Command.

Sharing Knowledge will be one of the most important principles of the Canadian Forces LLKW with relevance to simplicity, sustainability and credibility. The CF LLKW System shall provide an essential KM tool that becomes a significant factor in the development and the learning curve within the Canadian Forces while enabling a faster and more accurate decision making/sharing process. This will reinforce the Canadian Force Command-Centric Vision, providing a unified way of sharing knowledge between environments while merging the tactical, operational and strategic level into one workspace.

We can only hope that the work that we are currently doing will eventually benefit Canadian Forces as well as the ones from our Allies as time and precision in the decision making process is becoming an overwhelming preoccupation for everyone.

ACKNOWLEDGEMENT

This project was supported by the Directorate Land Command Information, National Defence Headquarters Canada and by the Defence R&D Valcartier Canada.

REFERENCES

[1] Department of National Defence Canada (DND), ARMY STRATEGY-Advancing with Purpose 2002. 33p.

[2] Department of National Defence Canada (DND), The Future Security Environment, Report Number 99-2, 1999.

[3] Department of National Defence Canada (DND), Army Knowledge Management Strategy Outline, Revision 1.4, September 2002, 10p.

[4] Gaétan Thibault, François Le May. Introducing the Canadian Information-Centric Workspace Concept, *Research & Technology Organisation Symposium on Military Data and Information Fusion*, 20-22 October 2003.

[5] David S. Alberts Information Age Transformation Getting a 21st Century military. Information Age Transformation series.

[6] Data Fusion Lexicon, Data Fusion Subpanel of the Joint Directors of Laboratories Technical Panel for C^3, F.E. White, Code 4202, NOSC, San Diego, CA, 1991.

[7] Thomas H. Davenport and L. Prusak. Working knowledge: How organizations manage what they know. Boston, MA: Harvard Business School Press, 1998.

[8] Rosina Weber, David W. Aha, Irma Becerra-Fernandez. Intelligent Lessons Learned Systems. International Journal of Expert Systems Research & Applications, Vol. 20, No.1., pp. 17-34.

[9] Anne-Claire Boury-Brisset, Marlène Gauvin, Pierrette Champoux, A Knowledge Management Approach to the Creation and Sharing of Canadian Forces Lessons Learned, *ICCRTS* September 2002, 17p.

[10] Pierrette Champoux, Marlène Gauvin, Anne-Claire Boury-Brisset, Applying Knowledge Management to Lessons Learned, *DND Knowledge Management Blue Print*, (*Chapter 10 Appendix)*, Department National Defense Canada, 2002, 10p.

[11] Department of National Defence Canada (DND), Future Army Capabilities, January 2001 48p.

[12] Champoux Pierrette. *Study on Task Analysis and Usefullness of a Case Base Tool during the Analysis Phase of Geomatic Development Project*. Ph.D. Thesis, Geomatic Science Department, Forestry and Geomatic Faculty, Université Laval, Québec, 289 p. 1997.

[13] Alan N. Steinberg, Christopher .L. Bowman, and Franklin .E. White *Revision to the JDL Data Fusion Model*, Joint NATO/IRIS Conference, Quebec City, October 1998.

[14] David L. Hall and James Llinas An introduction to Mutlisensor Data Fusion, Proceedings of the IEEE, Vol. 85, no1. January 1997, pp. 6-22.

[15] Tore Smestad, *Data Fusion- for Humans, Computers of Both*, Translation of an article in the periodical 'Mikroskopet' of the Norvwegian Defence Research Establishment published in February 2001, Norway, 6p.

[16] David W. Aha, Rosina Weber, Héctor Munoz-Avila, Leanard A. Breslow, Kalyan Moy Gupta, Bridging the Lesson Distribution Gap. *IJCAI'0,* Seatle, WA August 2001, Morgan Kaufmann Publishers, Inc. pp. 987-992.

[17] Weber, R., Aha, D.W., & Becerra-Fernandez, I. (2000). *Categorizing Intelligent Lessons Learned Systems***.** In D.W.Aha & R. Weber (Eds.) (2000). *Intelligent Lessons Learned Systems:* Papers from the AAAI 2000 Workshop, 63-67. (Technical Report WS-00-008). Menlo Park, CA:AAAI Press.

[18] Anne-Claire Boury-Brisset. *Ontology-based Approach for Information Fusion*. Sixth International Conference on Information Fusion, Cairns, Queensland, Australia, July 2003.

[19] Anne-Claire Boury-Brisset, Ontological Approach to Military Modeling and Knowledge Management, *Research & Technology Organisation Symposium on Military Data and Information Fusion*, 0-22 October 2003.

A Lessons Learned Knowledge Warehouse to Support the Army Knowledge Management Command-Centric (LLKW)

Information Systems Technology Panel Symposium: Military Data and Information Fusion

Dr. Pierrette Champoux,

Martin Trudel M.Sc., Gaetan Thibault M.Sc.

Prague, Czech Republic

September 2003

Presentation Content

- Introduction
- Army Lessons Learned Knowledge Warehouse (ALLKW)
  - Process Goals, System Requirements and Development approach
- LL Process
- Lessons Learned Process (LLP) and the Data Fusion Model
- ALLKW Content and Models
- Demonstration
- Conclusion

LLKW

Introduction

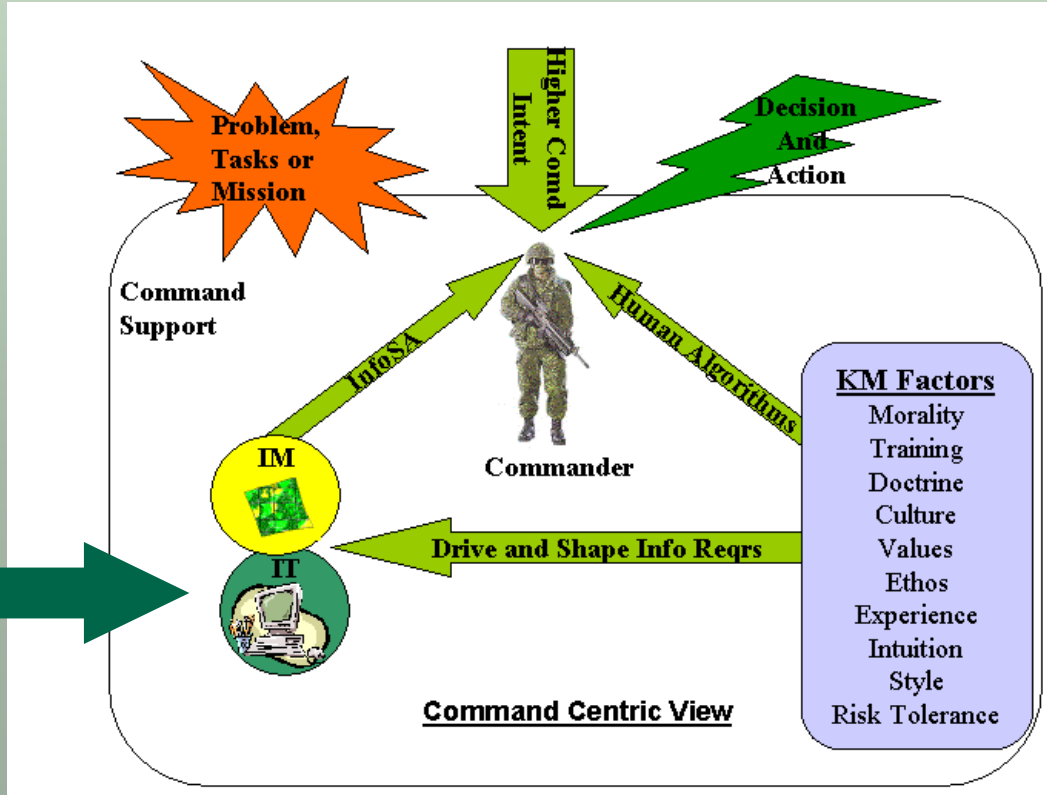
Army Lessons Learned Project Context

- The Department of National Defence investigated a new approach to the management and subsequent publications of the Lessons Learned Centre.
- This new approach will be based on a Knowledge Management approach and technologies will take into account the business processes related to the management of the Lessons Learned as well as the technological environment within the Army.

LLKW into the CC View KM

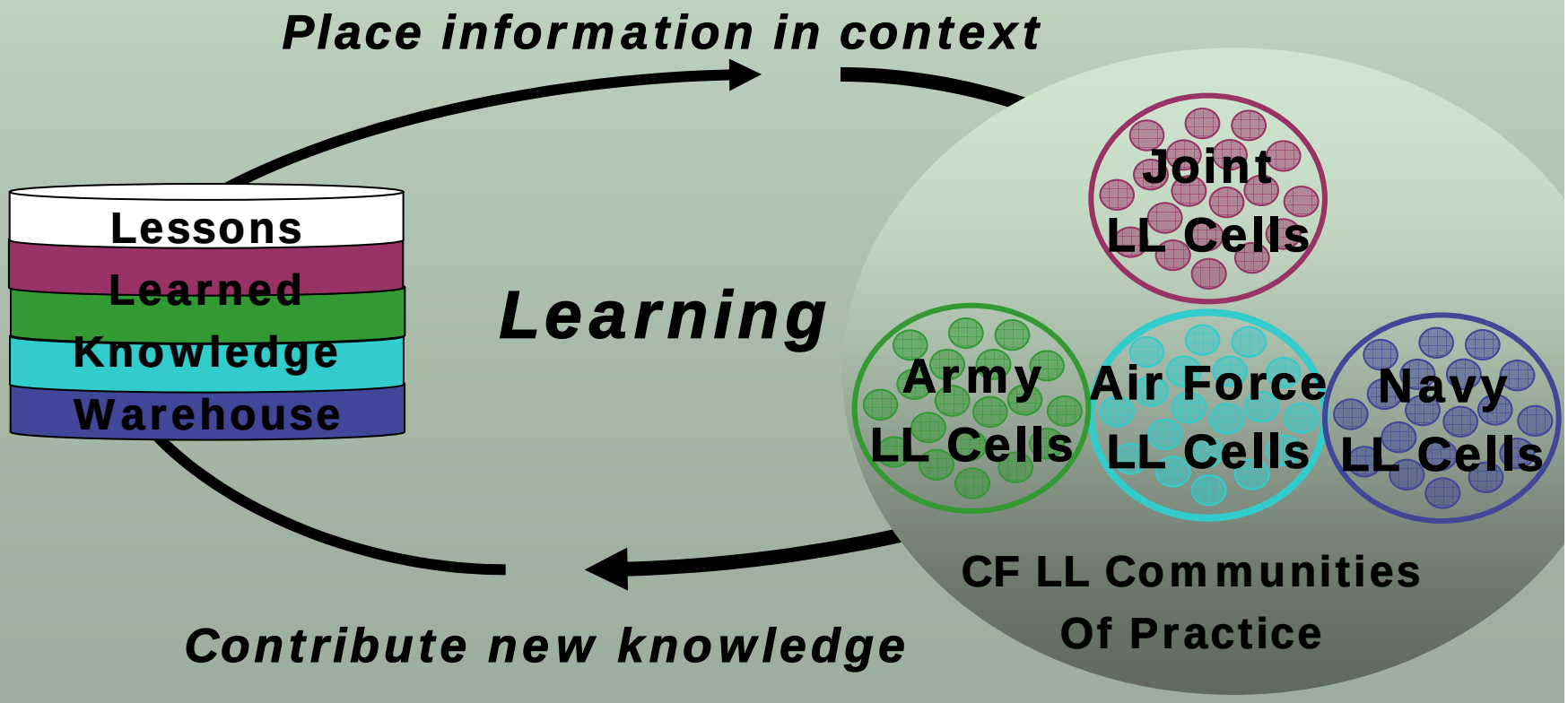
- *"The command-centric view of knowledge management is integral to the command support capability. It focuses on the usefulness of implementing knowledge management processes, techniques and tools to support Army commanders during decision-making in an operational context."*

LLKW



CLLKW part of the Knowledge & Learning Strategy

Knowledge Access **Knowledge Exchange**



Doctrine
ETSS
LLKW

LLKW

ALLKW

Process Goals, System Requirements and Development approach

Army Lessons Learned Process Goals

- To enable the Army to profit from its own experiences as well as those of the CF and our Allies;
- To avoid the duplication of costly errors, particularly those pertaining to death or injury;
- To emulate success and to consistently improve performance.

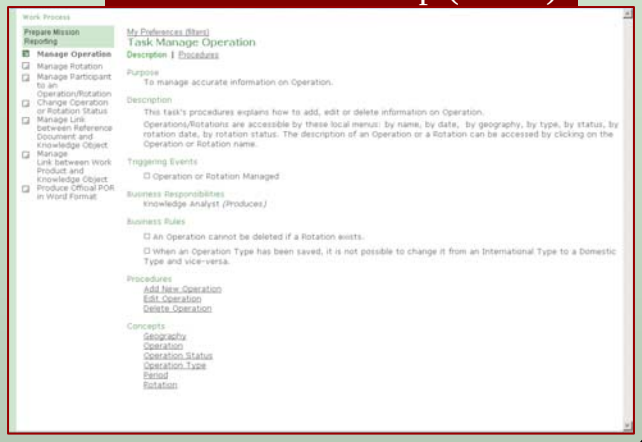
ALLKW Main Requirements

1. Accessing the System with a Browser similar to Internet Explorer.
2. Facilitating or enabling the capture of observations and comments from the Chain of Command.
3. Accelerating updates.
4. Providing tools to assist the Lessons Learned Analysts in the search and validation of specific issues as well as the identification of lessons.
5. Facilitating action tracking.
6. Enabling fast publishing.

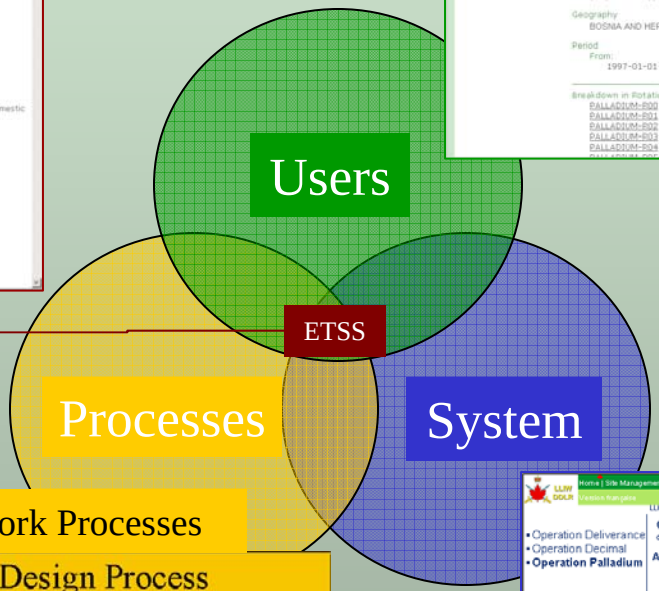
LLKW Development Overview

Manage Operation

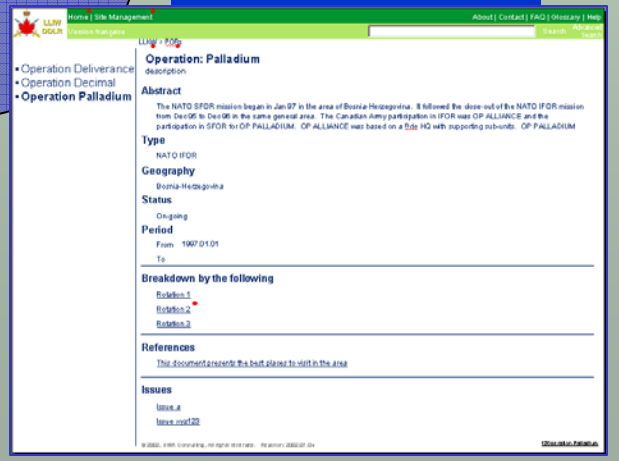
Use Contextual Help (ETSS)



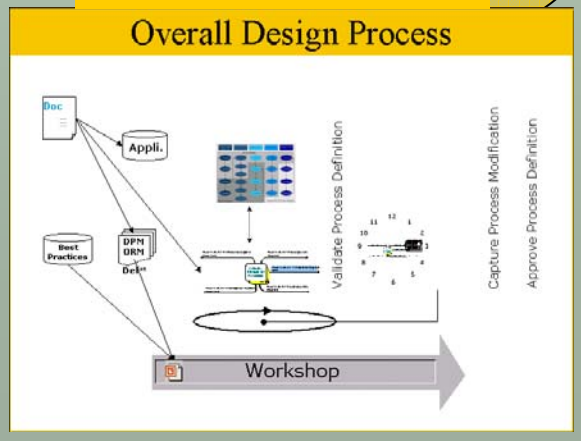
Electronic **T**ask **S**upport **S**ystem



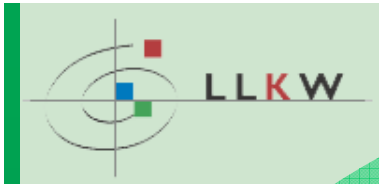
Develop Application



Define Work Processes



Lessons Learned Process (LLP)



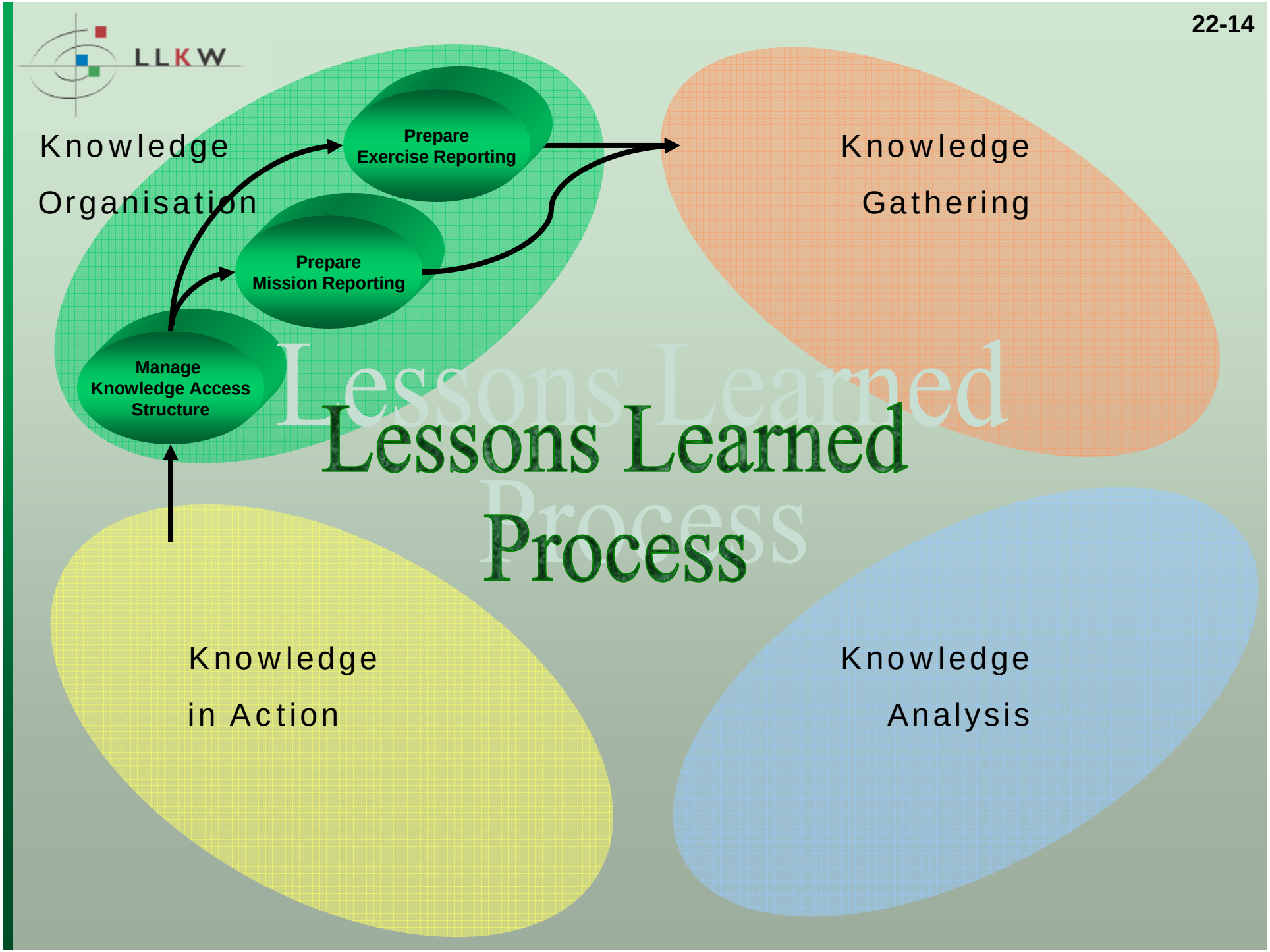
Knowledge Organisation

Knowledge Gathering

Lessons Learned Process

Knowledge in Action

Knowledge Analysis


LLKW
Knowledge Organisation
Prepare Exercise Reporting
Prepare Mission Reporting
Manage Knowledge Access Structure
Knowledge Gathering
Knowledge in Action
Knowledge Analysis
Lessons Learned Process

Structured Reporting Context: Questionnaire

- Phase: 4 – Employment
  - Theme: Command and Control (C2)
    - Subject: Unit Deployment Detail

Briefly describe the unit deployment in terms of:

a. Tour dates

b. Sub-units

(1) Number and type of sub-units deployed (to include sub-unit function, major eqpt and parent unit title).

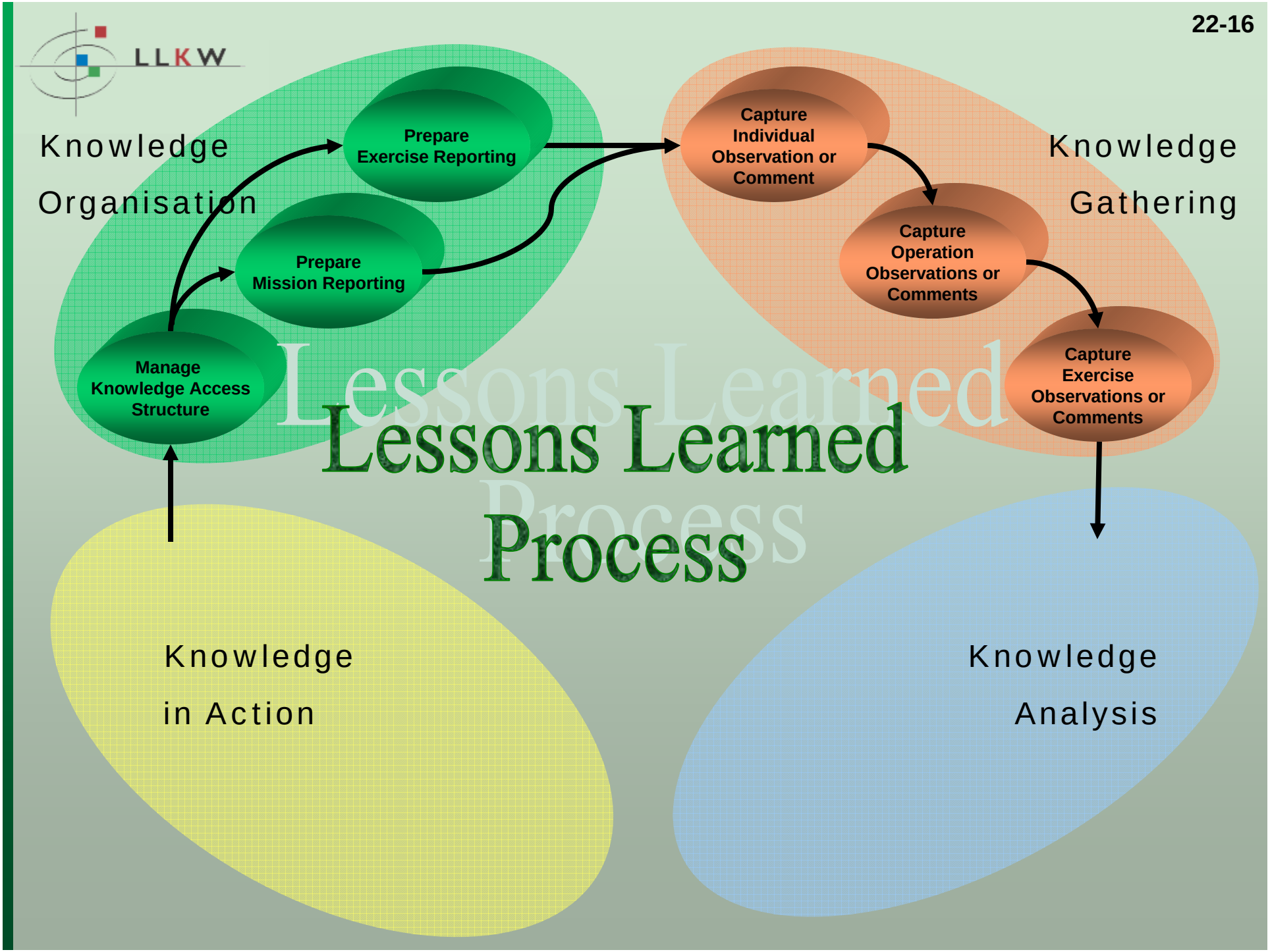
(2) Indicate if there was a change in unit organisation at sub-unit level for this mission.

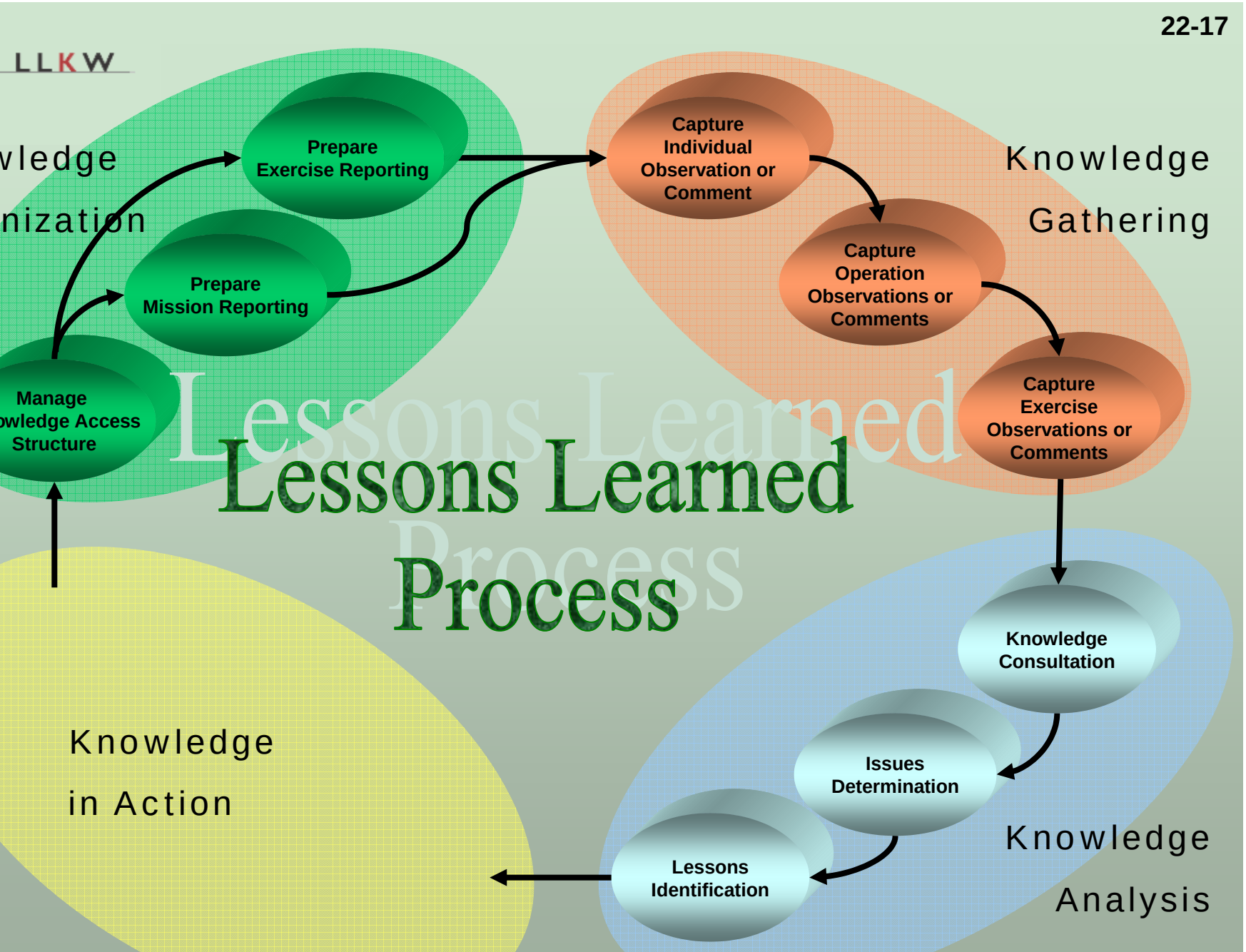
(3) If re-rolling was required, identify for applicable sub-units.

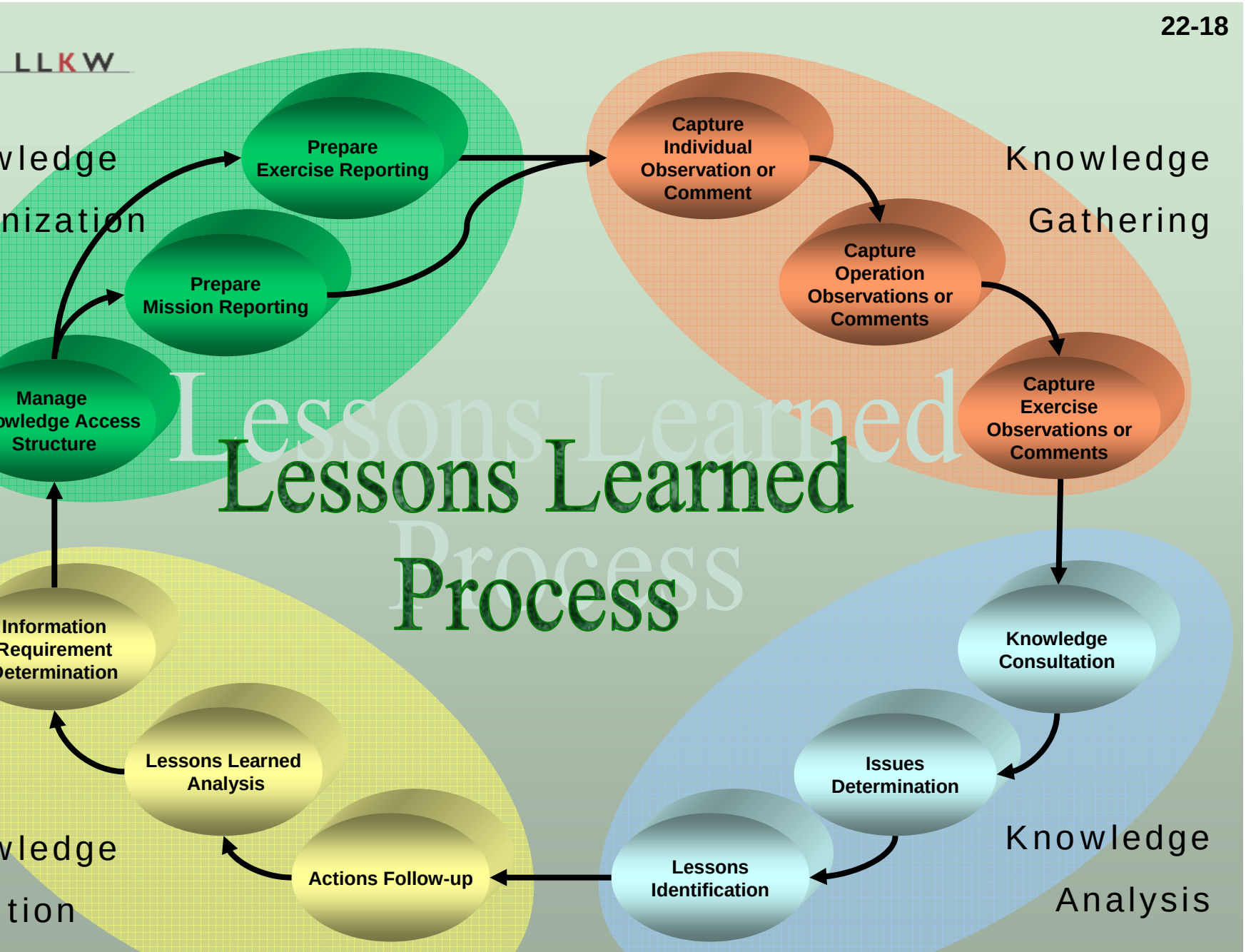
c. Total number of people deployed (Reg/Res)

d. Description of the location of the deployment (country/province/ major cities)

e. Were there momentous incidents or changes to the situation in the deployment area that had a major impact on the operation?


LLKW
Knowledge Organisation
Prepare Exercise Reporting
Prepare Mission Reporting
Manage Knowledge Access Structure
Knowledge Gathering
Capture Individual Observation or Comment
Capture Operation Observations or Comments
Capture Exercise Observations or Comments
Lessons Learned Process
Knowledge in Action
Knowledge Analysis


LLKW
wledge
nization
Prepare Exercise Reporting
Prepare Mission Reporting
Manage owledge Access Structure
Capture Individual Observation or Comment
Capture Operation Observations or Comments
Capture Exercise Observations or Comments
Knowledge Gathering
Lessons Learned Process
Knowledge Consultation
Issues Determination
Lessons Identification
Knowledge Analysis
Knowledge in Action


LLKW
wledge
nization
Prepare Exercise Reporting
Prepare Mission Reporting
Manage owledge Access Structure
Capture Individual Observation or Comment
Capture Operation Observations or Comments
Capture Exercise Observations or Comments
Knowledge Gathering
Lessons Learned Process
Information Requirement Determination
Lessons Learned Analysis
Actions Follow-up
wledge
tion
Knowledge Consultation
Issues Determination
Lessons Identification
Knowledge Analysis

LLKW

Lessons Learned Process (LLP) and Data Fusion

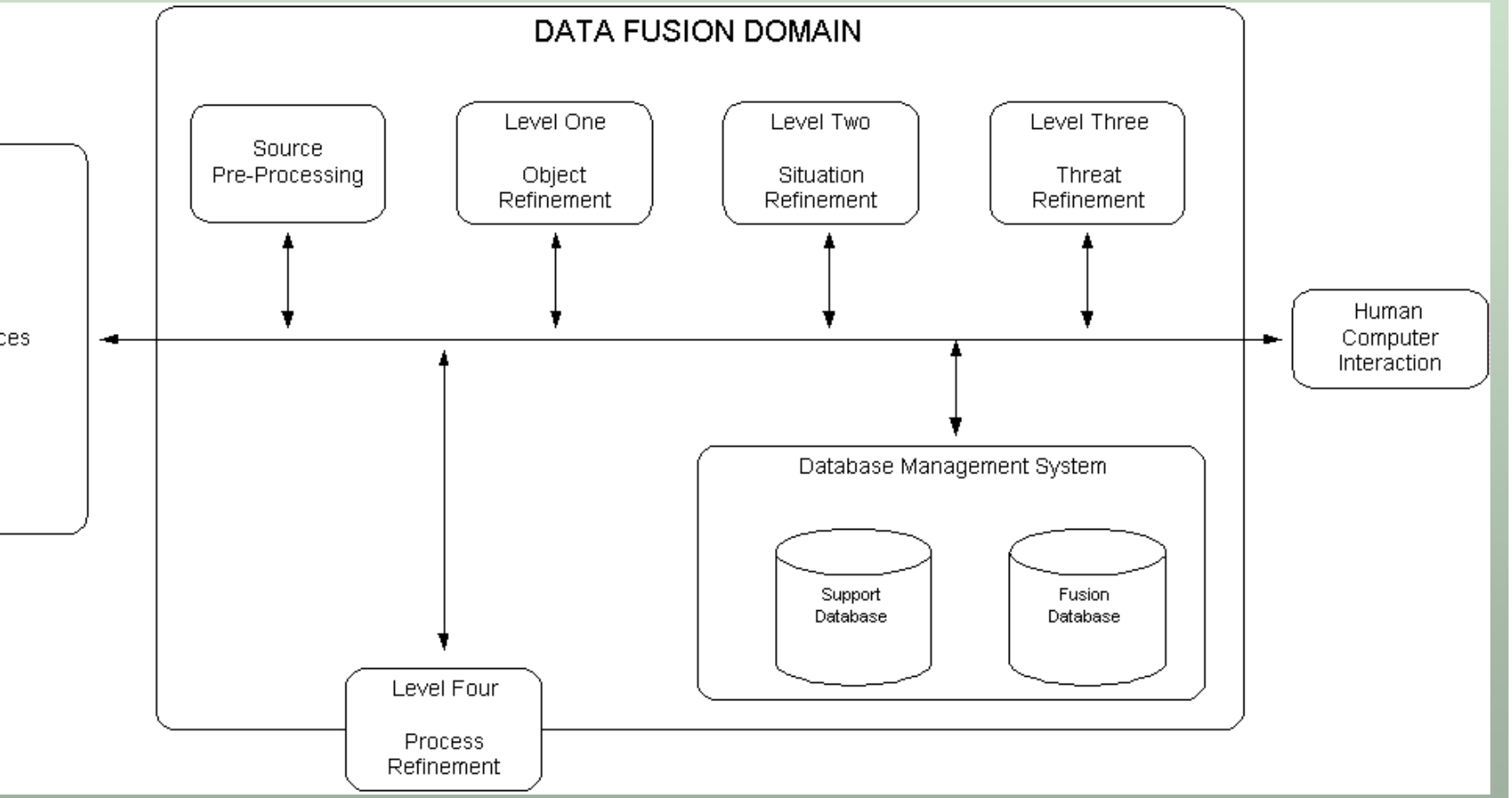
LLKW

Mapping between the LLKW System, Process and Information with the JDL Data Fusion Model

- How can the LLKW system be incorporated within the Data Fusion Process from the HCI point of view?
- Can the LL Knowledge Base provide any valuable information to achieve better estimates of the objects state? If this were the case, what should be the steps or actions taken?

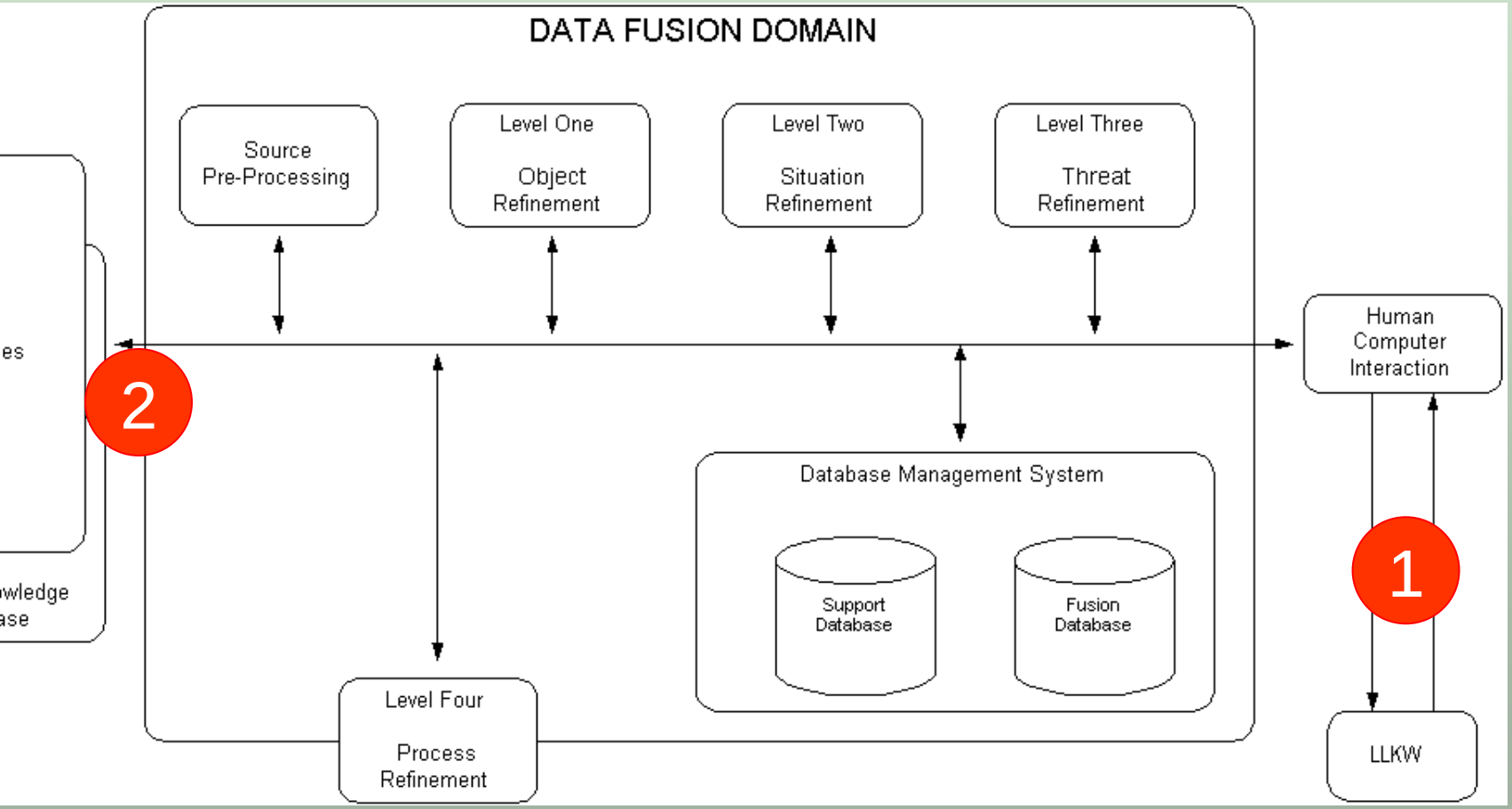
LLKW

Data Fusion Model and LLKW



LLKW

Data Fusion Model and LLKW



LLKW

Knowledge Organisation

Knowledge Gathering

Lessons Learned Process

Knowledge in Action

Knowledge Analysis

LLKW

Structured Knowledge in relation with Data Fusion Processes [22-24]

- Review the LLKW to capture context
  - Enhance Knowledge Base
  - Categorize Knowledge
- Define unifying terminology
  - Construct Domain Ontologies
- Define questionnaire
  - Specify questions based on fusion domain

Search through Air-Forces observations

Search

[Back to Main Menu]

Ontology Criterias

Ontology Finder: Go

Observations classified under (•) Any Category (OR) ( ) All Categories (AND)

- [ ] Air Force
  - [ ] Environment
  - [ ] Situation awareness
  - [ ] Document type
  - [x] Capabilities
  - [ ] Organization
  - [ ] Resources
  - [ ] State
  - [ ] Planning

Full-Text Criterias

Search for:

Find Results with: all the words

Observation Criterias

Select a Mission: All Missions

Date submitted From 1970-01-01 To 2100-01-01

Submit Clear

Search Result

Search Results

[Back to Main Menu] [Back to Search Criterias] [Show Criterias]

Suggested Categories

- Air Force
  - Capabilities
    - Tactics
    - Operational capabilities
    - Order
    - Visual search capabilities
  - Environment
  - Situation awareness
  - Document type
  - Organization
  - Resources
  - State
  - Planning

Suggested Concepts

personnel
exercise
deployment
information
operation

Search Results Grouped by Mission Number of hits: 603 Total time: 9.71875

Mission : Ex Abacus 2000

Problem: L'utilisation du réseau d'information de la défense (RID) pour la recherche d'in...
Categories: Capabilities, Information Technology
Concepts: exercise, information, sites, publications, pas, din, recherche, rid, est, 'information
Type: Not submitted

Problem: Le réseau d'information de la défense (RID) ne devrait pas être utilisé comme ou...
Categories: Coordination, Operation, Manning
Concepts: information, message, distribution, operational, op, pas, centre, din, devrait, ne
Type: Not submitted

Problem: ACOP 210 - Pub out of date
Categories: Capabilities
Concepts: capabilities
Type: Not submitted

Problem: No plan in place to communicate with outside agencies if commercial lines are de...
Categories: Capabilities, Organization, Facilities
Concepts: plan, communication, lines, coordinate, medical, agencies, shelters, hotels, vital, hospitals
Type: Not submitted

Problem: There are far too many DIN sites being used for this operation. Trying to find ...

LLKW

Analogy with the DFP

Data Fusion		Lessons Learned	
Processes	**Components**	**Components**	**Processes**
Level 1 – Object Refinement	Data alignment Data object/correlation Position/kinematic and attribute estimation Object identity estimation	Observations Comments	Knowledge Gathering
Level 2 – Situation Refinement	Object aggregation Event/activity interpretation Contextual interpretation	Issues Lessons	Knowledge Analysis
Level 3 – Threat Refinement	Aggregate force estimation Intent prediction Multi-perspective assessment	Actions Lessons Learned Recommendations	Knowledge in Action
Level 4 – Process Refinement	Performance evaluation Process control Source requirement determination Mission management	Questionnaires management Organisational Structure modification Reporting Context definition Users and Roles determination	Knowledge Organisation

LLKW

ALLKW

Content and Models

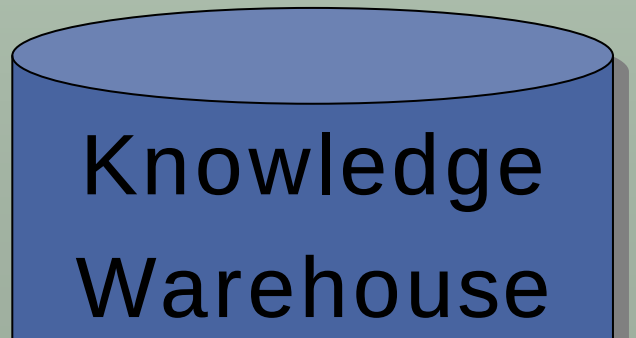
LLKW

Knowledge Management System Components

Army Lessons Learned

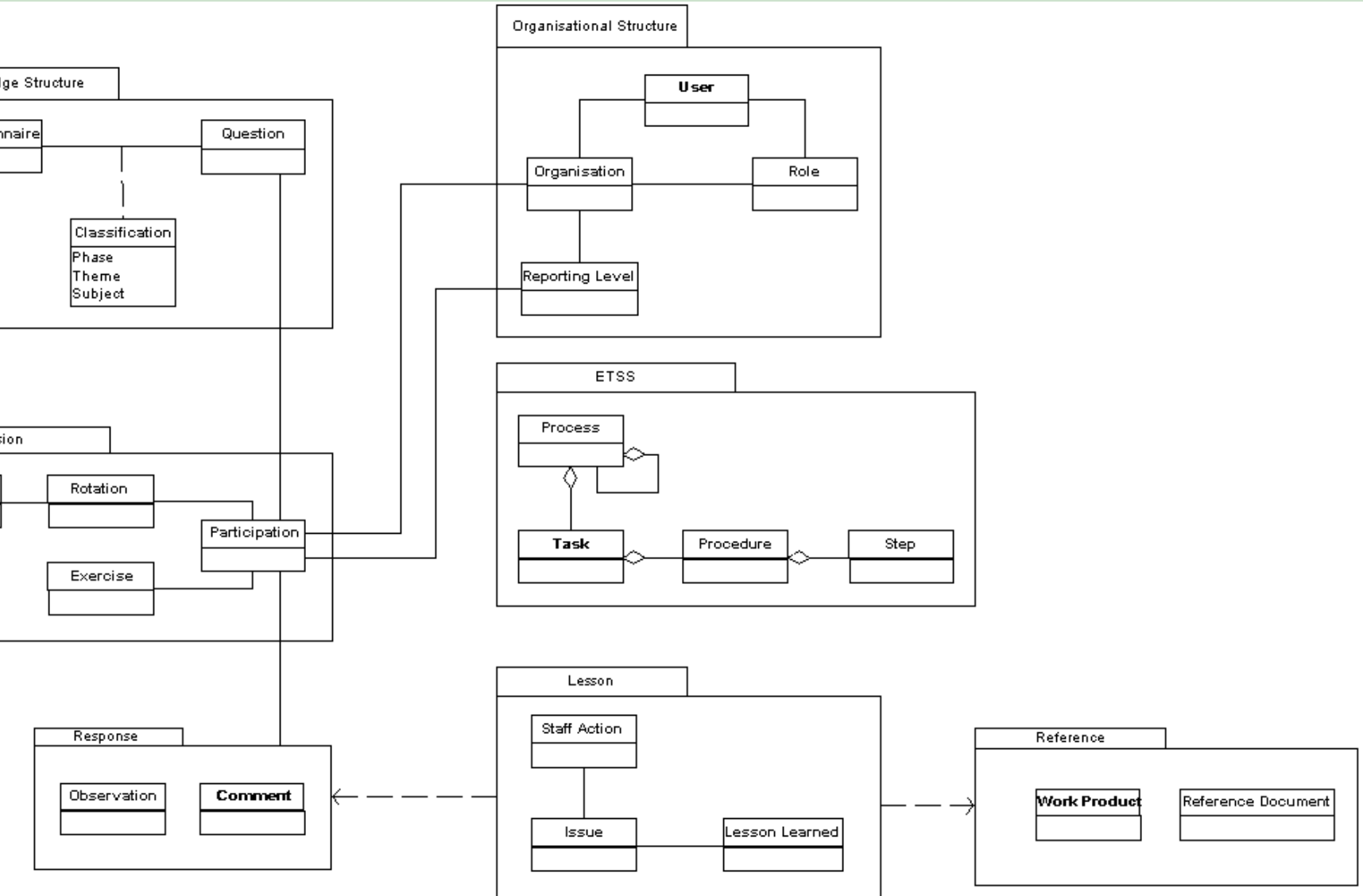
ETSS

Knowledge Framework



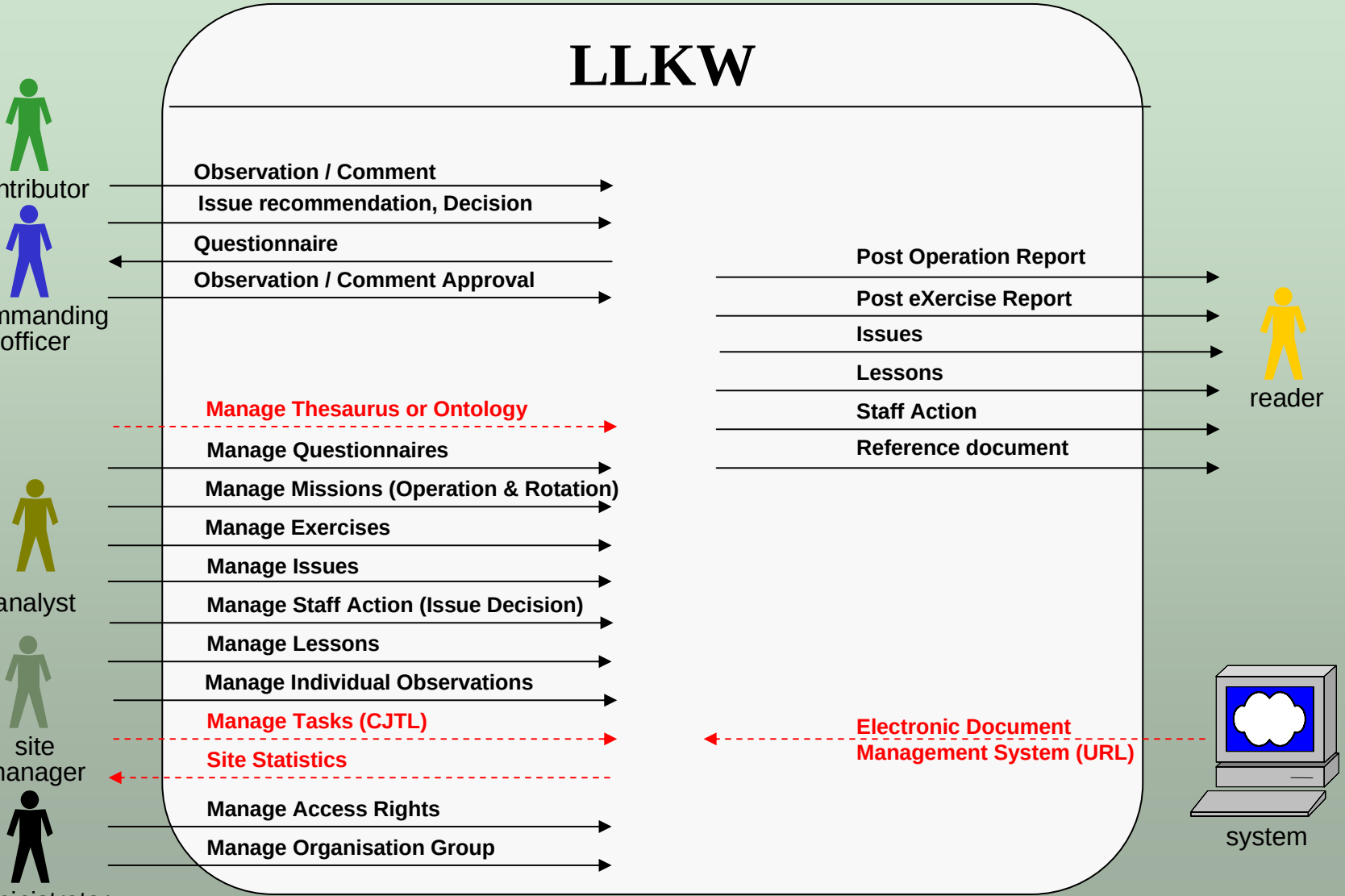
LLKW

LLKW Knowledge Object Model



LLKW

LLKW Context

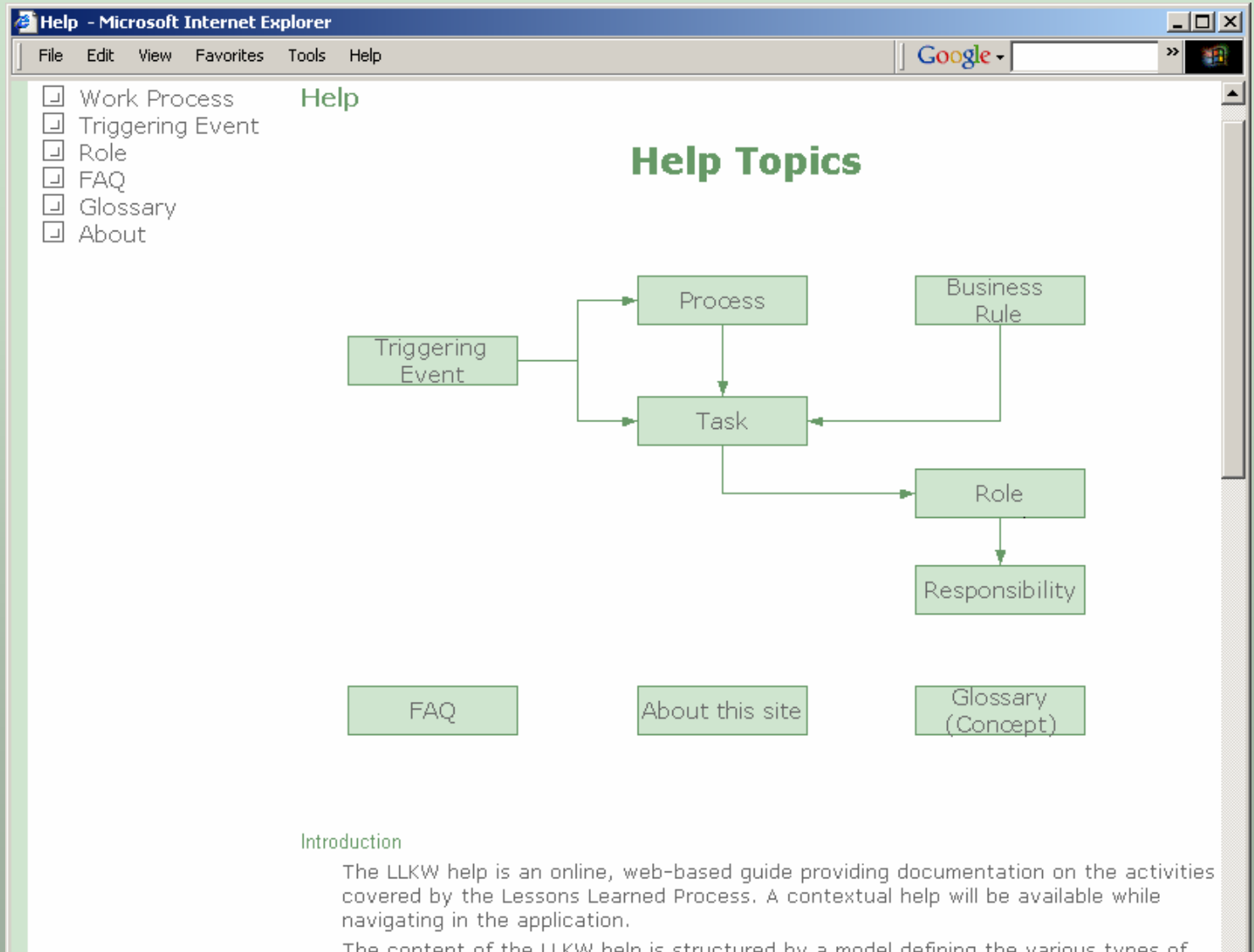


LLKW

Roles vs Management Functions

- Readers
  - Consults
- Contributors
  - PXR and POR Observations and Comments
  - Issues Recommendation, Decision, Action
- Administrators
  - Users and Access Rights
- Site Managers
  - Document Management Configurations
- Knowledge Analysts
  - POR
  - POR and PXR Questionnaires (Domestic and International)
  - Issues, Staff Actions
  - Lessons
  - Individual Observations Capture
  - Work Products, References

Electronic Task Support System for the LLKW



LLKW

LLKW Entry Point

PXR

Questionnaire

International | Domestic

onnaire

national | Domestic

Individual Observations

Staff Actions

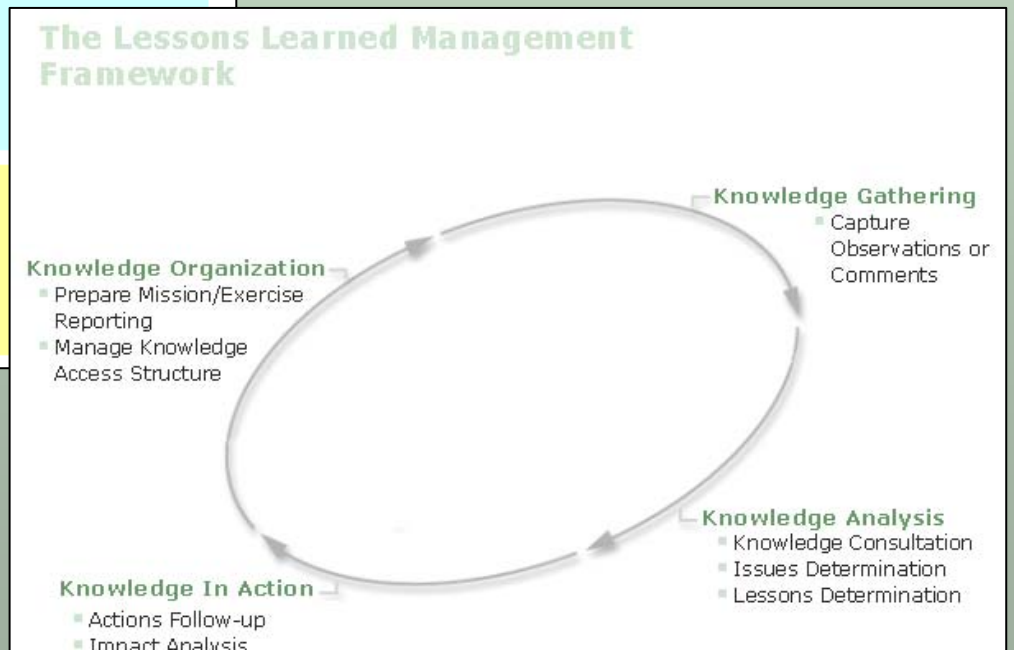
Lessons

roducts

References

LLKW Management Site

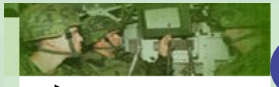
LLKW Reader Site



LLKW Interface

LLKW

Logo = Home



LLKW

Site Management Logout (kapc) Version française

About Contact FAQ Glossary Help

Search Advanced Search

Menu

Always available

cue

umb

umb trails link to all the y above ent

line

brother , from me

Army Home > POR > (Intl.) International> ECLIPSE

ECLIPSE-R00

Rotation: ECLIPSE-R00

description | by questionnaire

Local Navigator

Abstract

OP ECLIPSE was the Canadian contribution to the United Nations Mission Ethiopia Eritrea (UNMEE). The deployment was from 21 Nov 00 to 11 Jun 01. The contingent was based on 2 RCR Gagetown. A Coy Gp based on H Coy as well as Recce Platoon deployed. This was the first operational deployment of the LAV III APC to a mission area. an Engr Surge Sqn was deployed form 4 ESR Gagetown to assist in establishing the camp infrastructure. This was also the first case where a Theatre Activiation Team (TAT) was deployed from the CF Joint Operations Group (CFJOG) ahead of the arrival of the main contingent. At the end of the mission a Mission Close-out Team (MCT) was deployed to assist in the closure of the camp. UNMEE HQ was at Asmara. The Cdn NCE and NSE were located at Camp Groesbeek and the H Coy Gp was located at Camp Dunn. The Cdn Coy Gp worked with the Dutch Battle Group which had their HQ at Adigrat, Ethiopia.

Geography

ETHIOPIA

Period

From

2000-11-21

To:

2001-06-11

Participants

Reporting Level	Organization	Status	
1 - Unit	2 RCR	Approved	
1 - Unit	4 ESR	Approved	
1 - Unit	TAT	Approved	
2 - NCE	NCE	Approved	
3 - Brigade	CTC HQ	To be Commented	
3 - Brigade	JOG	Approved	
4 - LFA	LFAA HQ	To be Commented	
5 - LFC	CLS	To be Commented	

This Rotation is associated with the Following Phases:

Phase 1 - Warning
Phase 2 - Mounting
Phase 3 - Deployment
Phase 4 - Employment
Phase 5 - Redeployment

The associated Phases are from this Questionnaire:

2001

1 2 3 4 5 6

LLKW

Demonstration

- Overview
  - POR/PXR
  - Questionnaire (International & Domestic)
  - Issue, Lesson, Staff Action
  - Search and Filter
  - Help –Task Support System

LLKW

Conclusion

- Data Fusion and Lessons Learned aim at providing Knowledge
  - To be accessed in a timely manner
    - Knowledge must be properly organised, structured and classified ensuring the right balance between text and unstructured text to provide (i.e. push and pull) relevant lessons for specific situation
  - To be shared across domains to support the Command-Centric Vision
- Knowledge Environment for Data Fusion Domain to help manage, organise and capture
  - Evolution of the Data Fusion Ontologies
  - Formalisation of theory (event, behavior)
  - Relations between Knowledge Structures (processes, ontologies, doctrine)